The accessibility of school science textbooks to bilingual students

by

John Mark Benjamin Kearsey

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Abstract

Teachers may consider bilingual students to be linguistically disadvantaged. They may reason that making meaning of concepts in different languages leads to interference between the messages received and consequent confusion. However, bilingualism might help students to understand how languages work. This metalinguistic awareness would be a useful skill when students attempt to master the scientific language found in school science textbooks. Other aspects of textbooks such as the choice of contexts and figures, and the provision of glossaries may also affect the ability of bilingual students to make meaning of them.

This research is an attempt to investigate the circumstances in which bilingual learners might be at an advantage or at a disadvantage in understanding secondary school science textbooks. The use of the Nuffield Co-ordinated Sciences Biology textbook was investigated in twelve schools. Background information about the schools studied was collected by interviewing teachers and reviewing school documents, policies and inspection reports. Data concerning students' and teachers' attitudes and opinions were collected through interviews and questionnaires. More detailed linguistic information was collected through cloze procedures, discussion tasks, interviews and analysis of the textbook studied. A wide literature was reviewed concerning the structure of scientific language and school science textbooks and many aspects of the contexts of the use of these texts. Case study profiles were prepared for each of the schools studied which provided the context for the consideration of a computer analysis of coded data from questionnaires and cloze procedures. The findings provided evidence for three main assertions which arose from the research. First, that all students should be treated as a resource within the classroom. Secondly, that depending on the extent of students' bilingualism, their use of their languages and the context provided by the school, bilingualism may confer an advantage or a disadvantage to students making meaning of school science textbooks. Thirdly, that bilingual students are best served by school science texts of varied language complexity.

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Abbreviations

A list of abbreviations used in the thesis

ACT *Adaptive Control of Thought*
APU *Assessment of Performance Unit*
AO *Advance Organiser*
ASE *Association for Science Education*
BBC *British Broadcasting Corporation*
B Ed *Bachelor of Education*
BSA *Basic Skills Agency*
CHATTS *Children and Teachers Talking about Science*
CILT *Centre for Information on Language Teaching and research*
CRE *Commission for Racial Equality*
CSE *Certificate of Secondary Education*
DES *Department of Education and Science*
DESWO *Department of Education and Science and the Welsh Office*
DFE *Department for Education*
DFEWO *Department for Education and the Welsh Office*
DFEE *Department for Education and Employment*
EC *European Communities*
EFL *English as a Foreign Language*
ESOL *English for Speakers of Other Languages*
GCE *General Certificate of Education*
GCSE *General Certificate of Secondary Education*
GMS *Grant Maintained Status*
HCC *Hampshire County Council*
HMI *Her Majesty's Inspectorate of Schools*
ILEA *Inner London Education Authority*
INSET *In Service Education and Training for teachers*
I-R-F *Initiation Response Feedback*
JCGCSE *Joint Council for GCSE*
NCC *National Curriculum Council*
NCCT *Nuffield Chelsea Curriculum Trust*
NUT *National Union of Teachers*

NF *Nuffield Foundation*
MEG *Midland Examining Group*
MKCC *Milton Keynes Curriculum Consortium*
Ofsted *The Office for Standards in Education*
PGCE *Post Graduate Certificate of Education*
PSE *Picture Superiority Effect*
SEAC *School Examinations and Assessment Council*
SCAA *School Curriculum and Assessment Authority*
SSCR *Secondary Science Curriculum Review*

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And the Lord said, Behold, the people is one, and they have all one language; and now nothing will be restrained from them, which they have imagined to do. (Genesis chapter 11, verse 6, King James Version)

General introduction

My interest in multicultural education began when I encountered gypsy children early in my teaching career in Hampshire. I was supposed to be teaching them Environmental Science. Although lacking the kind of scientific knowledge which gets you through science examinations, is officially recognised by the scientific establishment and which has found its way into the National Curriculum for Science, these students possessed a great deal of understanding of the environment. After a while I had difficulty working out who was teaching whom. Those students taught me to respect the resources and cultures which students bring to the classroom. The concept of students as a *resource* in the classroom has been central to my educational philosophy ever since.

I met bilingual students from a range of other backgrounds on moving to Buckinghamshire. My involvement with the Bucks Swann Project which was a county initiative to produce multicultural science materials in response to the Swann Report and the experience of writing a multicultural science curriculum for the school where I worked, helped to clarify for me the depth of resources provided by these students. Like many workers in the field at the time I worried that the choice of figures and contexts and the assumptions made of the reader' s cultural background in textbooks might exclude bilingual and bicultural students. I tended to concentrate on contextual matters and the need to provide suitable role models for bilingual and bicultural students in textbooks rather than considering the effects of differences in competence in scientific English. I have since realised that this is a rather superficial view of the needs of these students. It was at about this time that I became involved in writing school textbook resources. I found that there was a dearth of information and advice for authors about writing for bilingual and bicultural students and the idea for this research began to form in my mind. In preparation for the research I studied an Open University Masters Degree course in Language and Literacy and encountered Halliday' s [e.g. 1978] ideas about functional grammar and Kress' s [1992] grammar of graphic representation for the first time.

These influences led me to realise that the language of scientific writing and diagrams poses problems for all students and I began to speculate on the particular problems faced by bilingual students in particular circumstances. However, the notion of students as a resource in the classroom nagged away at my subconscious. I also began to speculate about the ways in which bilingualism might be an advantage in understanding scientific language. These ideas began to take fuller shape on reading authors such as Cummins [1976], Diaz and Klinger [1991] and Bialystock [1991].

Bilingualism might confer an advantage in circumstances where students use both of their languages extensively within the home and in the wider community. A situation where a bilingual person fluent in both languages uses their languages for particular functions is called *diglossia*. One might expect that this sort of use of language might confer a knowledge about the way language works or *metalinguistic awareness* on the bilingual person. Such a language skill would help bilingual people to learn, use and understand scientific language which is also a form of language used for a particular function. In diglossic and scientific discourses speakers select from the language forms available to them on the criterion of the function of the discourse.

Bilingualism might confer a disadvantage if the bilingual person's two languages were confused in their mind to the extent that understanding in one language interfered with understanding in the other. Such *linguistic interference* would not help in metalinguistc awareness, if anything it might hinder its development. Unlike the situation in scientific discourse, these bilingual people select from the language forms available to them on the criterion of their own language capability in the two languages and that of the person they are communicating with. These bilingual people may have difficulty in selecting language forms such as scientific language, which depend on function.

Two important areas of research had opened up, the consideration of context which could be interpreted in many different ways and the consideration of language and text itself. At this point in the development of the research it was important to decide whether to focus on one particular aspect of the problem or to continue on a broad front. The broader approach was chosen for two reasons. First, such work would be of more benefit to me personally in my writing career and I had already decided that the development of my own writing should be an important outcome of the research. Secondly, I could see that the mapping of the breadth of the territory in this area could in itself make an important contribution to the literature on this subject. This approach was more likely to exploit the personal resources which I brought to the research. I hoped to offer this area of research the unique perspective of a teacher and scholar who is also a curriculum designer and writer who is familiar with the publishing scene. I was also privileged to enjoy easy access to many of the key personnel involved in the production of some textbooks and classroom practitioners on the one hand and leading academics in the field of social semiotics on the other.

I discussed these early ideas with Dieter Pevsner and Andrew Hunt at the Nuffield Chelsea Curriculum Trust. At that time Dieter was the publications manager for the Trust. Andrew who was working with me on a new Nuffield project had been general editor of the Nuffield Co-ordinated Sciences Project. They suggested that I should work on Nuffield Co-ordinated Sciences, which was at that time due for review. I elected to concentrate on the biology text. A research proposal was drawn up and comments considered from academics at King's College London, the Open University and the Institute of Education, University of London before the work was started at the Institute of Education in September 1992. The work was carried out on a part time basis whilst I continued to teach science in a secondary school part time and to work on various textbook and syllabus writing projects.

I am very grateful for the support and assistance which I have received from Dieter Pevsner and the Nuffield Chelsea Curriculum Trust. They provided me with advice and comment on the original research proposal, Desk Top Publishing and printing facilities, several copies of the textbook studied and access to their schools databases. They also paid some of the printing and postage costs. They officially adopted the project giving it a certain credibility. Dieter retired during the course of the project but I have enjoyed continued encouragement from Andrew Hunt of the Nuffield Foundation. Various other authors, publishers and classroom practitioners have also contributed to the work through their encouragement, advice and comment.

An overview of the research

Two research questions were developed concerning the effects of bilingualism on students' capability in understanding school science textbooks.

* Do monolingual and bilingual students have the same problems with school science textbooks?

* Is bilingualism an advantage or a disadvantage to students dealing with school science textbooks?

When these research questions were considered it became clear that it was necessary to define the extent of students' meaning making from text in some way. One can only comment on the problems that students have with text or the extent of advantage or disadvantage conferred by bilingualism if one can compare students' capabilities in understanding text in a reliable way. The concept of *readability* was found in the literature. This is related to the chronological age of an average student who should be able to cope with a text [Harrison 1980b pp. 12-13]. The concept of readability is of limited value in this research because it defines a property of texts rather than a property of readings of texts. There is no reason to suppose that the bilingual students studied are likely to be average or typical of the whole population, in fact the research aimed to identify differences between bilingual students and the general population. For this reason the concept of *accessibility* was developed. Within this research, accessibility is a term used to describe the capability of readers to make meaning of a text *with reference to particular readers in particular situations*.

One aspect of particular readings of the textbook studied of interest to the research was whether or not the readers were bilingual. For various reasons a broad definition of bilingualism was adopted and all those students who used a language other than English at home were considered to be bilingual. Not least was the need to use a definition which could be converted into a simple questionnaire question which would elicit consistent, valid responses from students in a wide range of circumstances. Comparisons were made between the capabilities of groups of bilingual students and between groups of bilingual students and groups of monolingual students to make meaning of a school science textbook.

The study of the influences on the capability of students to make meaning of a school a school science textbook revealed a complex problem. As Halliday [1991 cited in Winser 1994 p.18] points out, the relationship between text and context is "*dialectic and bidirectional*". It became clear that there are many aspects to the context of use of school science textbooks both "*contexts of situation*" and "*contexts of culture*". Both of these forms of context are relevant to this research. First, there are issues surrounding scientific language, the philosophy of science and the genre of textbooks. Secondly, there are issues concerning teaching, learning and reading. Thirdly, there are contextual issues concerning classrooms, science departments, institutions and national policy. Within this thesis the unifying thread in the discussion of these various, sometimes seemingly unrelated, paradigms is that they are all influential on students capability to make meaning of school science textbooks. The thesis demonstrates quite clearly the range of these influences and the complexity of their interactions.

The first part of the thesis (Chapters 1-3) comprises a theoretical framework for the study. The second part of the thesis (Chapters 4-8) is a description of the collection of data, their subsequent analysis and the conclusions drawn. Chapter 1 is a discussion of bilingualism and text. The discussion of bilingualism covers important issues, such as the impact of the Swann report on the education of bilingual students in this country, the effects of National Curriculum entitlement and recent research on the relationship between bilingualism and educational achievement. The section on text is a review of the form and development of textbooks. Chapter 2 deals with reading, learning and the interpretation of text. Issues such as the way in which school science textbooks are used are addressed in this chapter. These are important aspects of the contexts of the use of school science textbooks. Chapter 3 is a discussion of the language of school science textbooks and other forms of language which contribute to the linguistic context of their use.

Chapter 4 is a brief chapter which links the theoretical framework set out in the first part of the thesis with the description of the collection of data and discussion of the data analysis in the second part. It serves as an introduction to the school-based research. Chapter 5 is a brief critique of the textbook used by the students studied. This chapter includes a brief review of national issues affecting the use of the textbook in schools and a brief description of the textbook itself. The research methodologies used in the research are described in Chapter 6 and the data collected are analysed in Chapter 7. Chapter 8 is a discussion of the implications of the research, various recommendations arising from the work and suggestions for further research.

From the evidence collected and analysed it was possible to infer that under certain circumstances bilingualism confers an advantage on students who are making meaning of a school science textbook. However, there was no evidence in the data collected to show that teachers were aware of this possible advantage. There was some evidence from the analysis of the data collected to show that students who lived in a diglossic bilingual community performed better on a task which tested their capability in making meaning from the textbook studied than similar bilingual students from a more cosmopolitan bilingual community. It was also possible to infer from the evidence collected that the disadvantage of living in a community which was not diglossic applied equally to the socially advantaged student as it did to those from less advantaged homes.

There was evidence from the data collected that the problems which bilingual students have in making meaning of school science textbooks are similar to those encountered by other students. However, they might find particular texts very difficult. A surprise finding of the research was that none of the teachers who responded to the questionnaires, half of whom taught in schools with more than 10% bilingual students and some of whom were themselves bilingual, mentioned particular problems encountered by bilingual students using the textbook studied. It was concluded that, rather than providing bilingual students with particular texts intended to meet their specific needs, it would be better to ensure that a range of material was available to them to support activities involving texts of various linguistic difficulty. This need for differentiation of textbook materials was related to the standardised academic nature of the National Curriculum.

Various means of providing differentiated school science textbook materials are discussed in the final chapter of the thesis including the use of CD-ROM to provide interactive differentiated material and the use of a newspaper style of writing to produce single differentiated texts.

Chapter 1: Bilingualism and text

1.1 Introduction

The research discussed in this thesis concerns the accessibility of school science textbooks to bilingual students. Consequently, this first chapter introduces fundamental ideas about bilingualism and textbooks. *Bilingualism* is discussed in relation to learning, teaching, classrooms and text. A possible mechanism for the interaction between bilingualism and the understanding of scientific language is put forward. The discussion refers to the linguistic aspects of bilingualism on the one hand, and the cultural aspects on the other. A working definition of *text* is then broadened to include *textbooks* and the role of text. The chapter closes with a discussion of the relationship between *text* and *context* which is crucial to text and language understanding and introduces Chapters 2 and 3.

The argument centres on the learning of bilingual students within the British education system. However, the research findings have a wider field of application. As Strevens [1976 pp. 55-58] points out, science is taught through the medium of English to students whose first language is not English in many countries. For example, Letsoalo [1996] describes difficulties in the use of biology textbooks written in English with Sotho speaking Lebowan students in South Africa. In addition, the principles of the argument would apply equally well to science teaching to bilingual students in other languages. Strevens describes the problem of science teaching in a foreign language as "*immense*". This broad area and the effects of social class on bilingual science education [see also Gilborn & Gipps 1996 p. 81] are possible avenues for further research.

The author employs a liberal definition of bilingualism, treating as bilingual those students who at times use a language other than English at home. This approach is similar to that used by Roach, Smith and Vazquez [1994 p. 157]. It agrees with Wright's [1982] definition,

> "*being reasonably skilled in the use of more than one language*" [Wright 1982 p. 3].

Wright counsels on the limitations of this broad view. Representatives of a broad range of cultural groups including Eastern Europeans, Africans, Asians and regional

British cultures took part in the study. Those taking part also came from a wide range of social backgrounds. The study can claim to be truly multicultural.

1.2 Language and culture in teaching and learning

Language is essential to learning as the medium of the transmission of teaching and understanding, a tool for thinking and the means of organising learning. Emmitt and Pollock [1991] describe language as,

> "*a pane of glass through which we can view our thinking*" [Emmitt and Pollock 1991 cited in Scott 1992 Introduction].

Various types of language impinge upon the classroom and the author acknowledges that the textbook is but part of this total experience. Each student brings a unique set of personal resources with them to the classroom. Osborn, Jones and Stein [1985 pp. 10-11] describe how these personal resources contribute to the "*schema*" which students use as they read. Such prior knowledge is an important factor in learning (this argument is developed further in Chapter 2, see 2.3, 2.5.3). In the author's view, it is the teacher's job to recognise these personal resources and to value them. They can be shared to the benefit of all. As Bruner [1986] observes,

> "*most learning in most situations is a communal activity, a sharing of culture*" [Bruner1986 p. 127].

Edwards [1984 pp. 79-93] and Wright [1982 p. 4] urge that bilingualism should be seen as a resource in the classroom. They regret that bilingualism is, too often, considered to be a handicap. Linguistic diversity amongst students provides experience of other cultures and perspectives, an asset in implementation of the National Curriculum [NCC 1991a, 1991b, Runneymede Trust 1993 p. 7]. This experience is a useful resource in preparing all students for life in a pluralistic society. Kress [1994 p. 13] argues that a multicultural context leads to the consideration of representational, cultural, linguistic, social and historical aspects of text which might otherwise have been ignored. The Swann Report [DES 1985 pp. 191-198], traces the development of this "*multicultural*" approach to education. A growing pluralism in British society was first recognised during the late fifties and sixties. Early policies involved "*assimilationist*" and "*dispersal*" approaches. These were replaced by the "*integrationist*" policies of the seventies and the multiculturalism of the eighties and early nineties.

Just as language is a resource in teaching science, Kulkarni [1988 p. 155] and Cleland and Evans [1986], have shown that science can be a resource in teaching language and reading skills. The science teacher should recognise their role as a language teacher, possibly set out within a school policy for "*Language across the curriculum*" as advocated in the Bullock Report [DES 1975] and discussed in Chapter 2 (see 2.6.1). Turner [1992 pp. 19-22] describes the use of science as a context for second language teaching. Attitudes are very important in making use of bilingual resources in the classroom. International research [Wright 1982 p. 13] indicates that bilingual education depends on a positive attitude in the majority group towards minority languages and those who use them. Such attitudes are strengthened by using these languages as resources in the classroom.

1.2.1 Education for all

The Swann committee was set up in 1979 to report to Parliament on the educational needs and attainments of children from ethnic minorities [DES 1981, 1985] in response to concerns within the West Indian community [DES 1985 p. vii]. A 1977 European Directive [EC 1977] had raised the issue of mother-tongue teaching for the children of migrant workers. During the late 1950s and early 1960s attempts had been made to absorb ethnic minority children into the general population with a focus on language as a major problem. This "*assimilationist*" policy was implemented through specialist language centres and the dispersal of children between schools within broader areas where there were concentrations of ethnic minorities. Statistics were collected on numbers of "*immigrant*" children and financial provision was made through Section 11 of the Local Government Act 1966 [DES 1985 pp. 192-196]. It was assumed that once a family had been resident for ten years they would suffer no educational difficulties. The "*integrationist*" phase (the 1970s) was characterised by a growing awareness of the importance of ethnic minority students' backgrounds but still emphasised the need to compensate for "*deficiencies*" in order to absorb them into society, an important aspect being the acquisition of English [DES 1985 pp. 196-197].

Taking a broader view of the pluralist nature of contemporary British society, the Swann committee rejected both of these models in favour of a *"multicultural"* approach to education which had emerged during the late 1970s. However, they recognised the legacy of the earlier policies including the stereotypic assumptions made by some teachers [DES 1985 pp. 198-199]. This multicultural approach addresses the issues of educating all students for life in a multiracial society [DES 1985 pp. 199-228]. Multicultural education takes into account the failure of assimilation, evidenced in the concern of minority communities, by considering curriculum content, the encouragement of ethnic minority teachers and mother tongue teaching. A multicultural approach includes coping with racism and the need to provide teachers with suitable resources including training. Research [DES 1985 pp. 223- 224] indicated the continuing emphasis on English as a second language provision within multicultural policies. A 1984 EC report [EC 1984, Bourne 1990] commented that Britain was lagging behind other member states in implementing the 1977 directive. Only 2.2% of British primary children from minority language home backgrounds received mother-tongue teaching compared with 80% in the Netherlands.

Further reflection and consideration led the Swann committee to refine their proposed multicultural education model to *"Education for all"* [DES 1985 pp. 315-365]. This philosophy was defined as education for social and racial harmony which celebrates and respects the global diversity of cultures. It has implications across the curriculum both *open* (academic courses) and *hidden* (developing appropriate attitudes and responsibilities). Multicultural education has a particular role to play in combating racism and other practices and procedures which work against ethnic minority students. It applies to all schools. *Education for all* opposes *separate provision* and *tokenism* in multicultural provision. However, some ethnic minority students have special needs, including language needs, which should be provided for [DES 1985 p. 325].

The Swann committee emphasised that special language provision should be made within mainstream education rather than by withdrawal and that it is the responsibility of all teachers [DES 1985 pp. 392-395]. The report emphasises the need for English as a second language provision or instruction **in** a mother tongue, rather than instruction **through** a mother tongue or bilingual teaching [DES 1985 pp. 397-411].

The committee pointed out that ethnic minority students share some language needs with majority students, especially those unfamiliar with Standard English. The report also covers the difficult and inappropriate use of language in subjects such as science [DES 1985 pp. 414-417]. The report deals with the implications of *education for all* on teacher education and the recruitment of ethnic minority teachers [DES 1985 pp. 541-615]. The "*strategy for implementation*" set out in the report [DES 1985 pp. 364-365] influenced opinion and has affected subsequent legislation. The debate following the publication of the report led to the development of multicultural and antiracist policies, INSET and materials at the school level [e.g. Roberts 1988], the county level [e.g. Bucks Global science Group 1990, Bucks Swann Project 1990] and the national level [e.g. Thorp, 1991, Thorp, Deshpande & Edwards 1994, ASE 1991, NUT 1989, 1990].

A 1993 survey of educational support for ethnic minority communities [Ofsted 1994c p. 1, e.g. Ofsted 1995a pp. 3, 35-36] reported that in 1993/94 £154 million was spent on education under Section 11 in 96 out of the 108 Local Education Authorities, with the emphasis still on ESL (English as a Second Language) projects. There were 450 projects contributing to the costs of 14,000 (9,000 full time equivalent) additional teachers. However, the restatement of Government policy regarding RE and compulsory daily Christian worship in schools [DFE 1994 pp. 1, 10, 12-16, 20-24], changes to the rules controlling Section 11 funding [Passmore 1994a, Prestage 1994, Rogers 1994, Pyke 1995],

> "*a narrow form of interpretation of history and culture in the National Curriculum*" [Klein 1995b p. 9]

and speeches by the Chief Executive of SCAA (School Curriculum and Assessment Authority) [Halpin 1995, Hofkins 1995b, 1995c, Malik 1995, MacLeod 1995], suggest a shift back towards assimilationist attitudes. As Paul Black [1995] put it,

> "*Since June 1990 the nostalgic ideology of the New Right has driven education policy*" [Black 1995 p. 3].

1.2.2 Entitlement

Chapman [1994 p. 139] sets out the implications, for bilingual learners and their science teachers, of the entitlement curriculum laid down by the 1988 Education Reform Act. All students have a basic and fundamental entitlement to a curriculum which is "*balanced*", "*broad*" and "*relevant*". The Department of Education and Science explanatory document *From policy to practice* also embraces the concept that such a curriculum, "*must be fully taken up by every pupil*" [DES 1989b section 2]. Accessible science textbooks should be part of that entitlement. Hoyle [1994 p. 153] suggests that one aspect of equality of opportunity is for students to gain access to the language of science, its "*register*". Even fluent readers require direction and support in obtaining information from science text written in the science register. As Roach, Smith & Vasquez [1994 p. 163] point out, such help is even more important to bilingual beginners and other non-fluent readers.

1.2.3 Attitudes to bilingualism

Evans [1994] writes that, in the main, British people are monolingual and insular. Blackburne [1993] reports that we tend to devalue minority languages and some versions of English. However, research indicates that tri- and multi- lingualism is not uncommon in Britain today [Marland 1985 p. 29, Torbe 1990 pp. 145-146, Rosen & Burgess 1980]. Sutcliffe [1995] suggests that bilingualism could be a valuable resource in the local and national economy. Hornby [1977 p. 1] estimates that over half the peoples of the world speak more than one language. In a shrinking world perhaps we should reappraise our attitude towards bilingualism. On the other hand, as McKie [1995] points out, English is a ubiquitous, dominant, world language.

1.2.4 Language factors

Scientific English is a form of Standard English. However, Standard English is not the preferred dialect of many native English speakers. Standard English is a form which many monolingual English speaking students only encounter at school, speaking another dialect of English most of the time. These monolingual students share similar difficulties in interpreting scientific English with some bilingual students. In common with some monolingual English speakers, those bilingual students who are familiar with Standard English are at an advantage in understanding scientific English. Some bilingual students know only the Standard English of the classroom whereas many monolingual native speakers know only the Non-Standard English of the home and the street. Learning to master two languages may enable bilingual students to overcome the pitfalls associated with scientific English. In a recent review of research into the effects of the languages spoken by students on learning in science in various countries, Baker and Taylor [1995] concluded,

> "*that the personal construction of meaning in science is related to the linguistic background of the learner, and to the compatibility of the learner's language with that of science education*" [Baker & Taylor 1995 pp. 696-697].

Assessing the advantages and disadvantages in accessing scientific English associated with bilingualism is a complex problem.

There are other problems associated with languages which have no scientific discourse, or which are inadequate in science register terms, or scientific lexis (see Chapter 3: 3.6). If words cover slightly different concepts in different languages literal translations may be very confusing. For instance, Khatete [1994] related how school students whom he interviewed in Kenya confused *cold* with *wet* because there is no distinction between these concepts in the Kishwahili language. Metaphor, described by Kress [1985a p. 72] as, "*a necessary strategy*" may cause considerable problems in translation. Sharwood-Smith [1991, pp. 18-19] discusses the problems for bilingual students caused by the differences between "*syllable timed*" languages such as French and "*stress-timed*" languages such as English and between languages where word order is unimportant such as Chinese and those such as English where it is crucial.

The author asked a group of bilingual, education Ph D students and academics attending an international summer school to reflect on the language problems which they had had with scientific textbooks written in English [Kearsey 1994]. Native English speakers came up with some of the same problems as the non-native speakers. These are highly successful, intelligent, articulate and well motivated students and teachers, yet they reported many problems with scientific English. They have much more experience of both English and science than most bilingual school students. The fact that such people have such problems it indicates the difficulties faced by the average bilingual student in a school classroom.

The group listed problems with technical vocabulary, the complicated structure of scientific English, punctuation, the use of metaphor, structural signposts and subtle differences of meaning between literal translations. A Portuguese student mentioned *phrasal verbs* such as *take off* [Quirk & Greenbaum 1973 pp. 347-352, 358]. Such verbs do not appear in Portuguese. An Italian student reported problems in the meanings of words which have a Latin derivation. The group also mentioned some advantages of English over particular languages, for instance English texts are shorter than the equivalent Portuguese or Greek text. These and related issues are discussed in more depth in Chapter 3.

The students and academics recommended the use of bilingual dictionaries. However, there are problems with dictionaries especially in languages inadequate in science register words. The students and academics also suggested that bilingual school students should use the context to work out the meanings of scientific words. Unfortunately this involves features of the text such as cohesion, scientific constructions and the unfamiliar impersonal nature of science text. They recommended that bilingual school students should read more scientific English and should speak as much English as possible. These solutions assume a good understanding of everyday English and opportunities to try it out. Some bilingual school students have few English friends and,

> "*in those family settings where bilingual language use is a realistic possibility the majority of interactions do take place in the minority language rather than English*". [The Linguistic Minorities Project quoted by Marland 1985 p. 29].

Other suggestions included looking at, or making, drawings, reading through the text several times and finding a bilingual teacher.

Rollnick and Rutherford [1996] point out that,

> "*the use of the vernacular language is a powerful medium for exploring existing ideas*" [Rollnick & Rutherford 1996 p. 102]

and commend a "*mixed language strategy*" in teaching science to bilingual students. Unfortunately, finding a bilingual teacher, is very difficult advice for some speakers of Asian and African languages in Britain to follow. It is a particular problem in multicultural classrooms. One might find a bilingual teacher in Welsh/English or Gujarati/English, but there are situations where 40+ languages are spoken by students, (see for example Appendix A Schools 1004, 1018, 1019, 1020). As Dodson [1982, 1983 p. 413] explains, there is a shortage of bilingual teachers in Britain. Some of the other suggestions involve giving extra time for bilingual students to complete their work. This solution has important implications for classroom management and school organisation. There is also the question of where such extra time could be found within a crowded curriculum which some teachers perceive as overloaded and prescribed through National Curriculum entitlement.

1.2.5 Cultural factors

Eurocentrism and the suitability of contexts are issues in the accessibility of school science text. Cultural matters regarding images in school science text are covered in Chapters 2 and 5 (see 2.4-2.4.4 & 5.4-5.4.2). The genre of school science textbooks (the social aspect of the language including the implied relationship between author and reader) also has cultural implications. Cultural experience and community aspirations vary a great deal. Bilingual students may have a lifestyle which, to all intents and purposes, is British. Alternatively, they may live entirely within an ethnic community a life which is more akin to life in another country. Many minority communities value religion alongside language as a means to transmit culture [Ahmad 1975, Wright 1982 pp. 10-12]. Religion exerts important influences over views and values on scientific matters such as evolution and anatomical education. Religion and culture may affect attitudes to gender and the authority of the teacher. New technologies such as cable TV, local radio and desk top publishing have made local small-scale media a viable reality. These may provide a life-line for minority languages and cultures. Bilingual students may be used to, and skilled at, matching appropriate language use to particular situations. In a recent review of research into the effects of students' cultural backgrounds on learning in science in various countries, Baker and Taylor [1995] concluded that,

> "*students' cultural background is likely to affect their ability to fully comprehend*

and manipulate scientific concepts" [Baker & Taylor 1995 pp. 697-698].

Wright [1982 p. 4] writes that rich and powerful people have always favoured bilingualism. Cummins [1976 pp. 18-19] shows that this "*elitist*" bilingualism has proved to be an asset to those concerned throughout history. Skutnabb-Kangas [1984 pp. 75-76, 79-80, 97] observes that elite bilingualism tends to be "*voluntary*", compared with the "*strong external pressure*" exerted on children from linguistic minorities to become bilingual. A Welsh survey [Council for the Welsh Language/Cyngor yr Iaith Gymraeg 1978, Harrison et al 1981], showed that socioeconomic status was important to language loyalty whereas Khleif [1980] claims that loyalty to minority languages poses a dilemma for social mobility. This apparent contradiction can be explained in terms of the need for the social/linguistic skill of selecting the right language for the situation and of switching between languages where appropriate. As Skutnabb-Kangas [1984 p. 76] points out, social standing can help in learning these skills.

Questions of identity and cultural conflict contribute to student attitude, motivation and performance. Wright [982 p. 14] comments that the teacher's recognition of cultural differences can affect performance. In one school studied by the author (School 1031), where teachers did not even know the names of the languages spoken by their bilingual pupils, students were reticent about stating their cultural identity. The "*cultural capital*" identified by Bourdieu [1974 p. 32] which bilingual students bring to the classroom is a valuable resource. It should not be squandered in this way. In the author's view, science courses and materials should provide positive images of Third World countries such that bilingual students are encouraged to be proud of their origins.

1.2.6 Bilingualism and cognitive development

Various authors [see Wright 1982 p. 2, Dodson 1983, Saunders 1982] have suggested that bilingual children learn neither language well and that the brain effort required hampers learning. In early IQ tests [Wright 1982 pp. 3-4, Christopherson 1973 p. 79], bilingual students scored less well on verbal intelligence tests. However, Peal & Lambert [1962] criticised this research because there were no control for factors such as socio-economic status and testing in the second, weaker language

Wright [1982 pp. 15-16] describes the dramatic proof provided by the celebrated 1970 San Franciso case. 45% of elementary children with Spanish surnames in classes for the mentally retarded were found to be of average or above average intelligence when retested in Spanish . Darcy [1953] showed that the bilingual students' language handicap on verbal tests was not evident in non-verbal tests.

More recent studies suggest that bilingualism can have a positive effect on cognitive development. Wright [1982 p. 4] explains the effect through reference to the Russian linguistic psychologists and "*the process of objectification*". He claims that bilingualism assists understanding of the symbolic nature of language. Various authors [Wright 1982 p. 4, Bialystok 1987, Cummins 1978, Diaz & Klingler 1991 p. 175] argue that bilingual children are more sensitive to semantic relations between words and objects than their monolingual peers. Johnson [1991] discusses these effects of bilingualism in terms of,

> "*a repertoire of infralogical (i.e., particular-experiential) and logological (i.e., generic-conceptual) structures which can be accessed through either language.*" and "*executives*", "*cognitive control processes [...] engaged in mental planning and the temporal structuring of mental processing and action*" [Johnson 1991 pp. 195-204, 216].

The distinction of infralogical and logolological structures from *linguistic* structures (e.g. lexical terms and grammatical relations) allows the bilingual student to examine language from what Johnson describes as an *intellective* position and thus facilitates objectification. Bialystok [1991 pp. 113-140, 1986a, 1986b, 1988] considered "*metalinguistic awareness*", suggesting that bilingual people have greater "*mastery of analysis and control*" of language than their monolingual peers [see also Cummins 1978 p. 48, Malakoff & Hakuta 1991 pp. 147-149, Diaz & Klingler 1991 p. 184].

Ben-Zeev [1977 p. 30-31] suggests that it is the very business of separating the two languages in the mind of the bilingual student which stimulates thinking about language systems, language analysis, sensitivity to feed back cues, maximization of structural differences between the languages and neutralization of structure within a language. This linguistic analysis stimulates cognitive development. These skills would also help students to understand the science register. Having reviewed the literature, Cummins [1976, Cummins & Swain 1986] and Diaz [1985, Diaz & Klingler 1991 pp. 178-179] proposed "*threshold*" hypotheses for the cognitive effects of bilingualism. If proficiency is below a lower threshold in one language the effects of bilingualism are subtractive. If it is above an upper threshold in both languages the effects are additive [see also Malakoff & Hakuta 1991 p. 141]. The following description by Diaz and Klingler [1991] is helpful,

> "*Additive bilingualism refers to situations where both languages are supported and develop in parallel. Subtractive situations are characterised by a gradual loss of the first language as a result of increasing mastery and use of the second language*" [Diaz & Klingler 1991 p. 175].

Cummins developed the theory further [Baker 1988 pp. 178-179] asserting that whereas "*surface fluency*" in the two languages may develop independently, "*cognitively demanding communication*" develops interdependently. Assuming that personal linguistic histories are similar within communities, the threshold theory accounts for experimental findings [e.g. Driver & Ballard 1980, Robinson 1980, Brooks & Singh 1978]. In the style of ethnographic studies of reading [e.g. Brice-Heath 1982 pp. 28-38], one might associate stimulus rich, interactive, middle class homes with additive bilingualism and less stimulating working class homes with subtractive bilingualism. Whilst Robinson's work [1980 pp. 149-150] supports this assertion, Driver and Ballard [1980 pp. 155-156] provide evidence to the contrary.

Dodson [1983] suggests that society's attitude towards bilingualism is more important than its inherent advantages or disadvantages.

> "*What we think of those languages, how highly we regard them, how we deal with the child learning them and as a consequence, the self image the child develops in the process of acquiring two languages.*" [Dodson 1983 p. 405].

Wright [1982 pp. 4-5, 13] is disappointed that bilingualism may be a "*liability*" to students because it is put to no use in education. He suggests that bilingualism is a resource which should help educational progress. By ignoring this resource, teachers give first languages a low status, affecting the self image of students. This author finds Dodson's claims difficult to refute or support, finding it impossible and unhelpful to separate the effect of bilingualism from the effect of society's attitude. Both social context (see Chapter 2) and linguistic matters (see Chapter 3) are considered to contribute to the accessibility of science textbooks to bilingual readers. He argues that it is more important to consider the individual and combined effects of these factors than to their ascertain their relative importance.

1.2.7 Bilingualism and scientific language

As Macnamara [1970] points out bilingual student's difficulties with language,

> "*can arise from something other than ignorance of certain words, idioms and syntactic structures; they can arise from a fairly generalised unfamiliarity with and poor control of the standard language, at least in written form,*" [Macnamara 1970 p. 34]

However, the different "*linguistic perspectives*" [Cummins 1976 p. 31] offered by the bilingual student's two languages and the switches in "*cognitive style*" available to "*bicognitive*" students who "*can cope effectively with two cultures*" [De Avila & Duncan 1985 p. 248], are comparable with the different linguistic perspectives and cognitive demands of common parlance, Standard English and the science register. Macnamara [1967] points to,

> "*bilingualism and diglossia... [...]... as salient examples of a capacity for code variation which is also to be found among monolinguals.*" and observes that several authors, "*advocate the use of a single theoretical model to handle all code variations whether monolingual or bilingual*" [Macnamara 1967 p. 3].

Cummins [1976 pp. 31-32] links the two linguistic perspectives of the bilingual student with the objectification theory of the Russian psychologists to show how bilingualism can have a positive effect on cognitive development. The author proposes a similar model for the effect of bilingualism on the understanding of scientific language.

A community where there is widespread fluent bilinguality tends towards "*diglossia*"

[Hornby 1977 p. 7], a situation where the different languages are used for different purposes [Crystal 1987 pp. 43, 362, Macnamara 1967 p. 3]. Switching between languages may enhance or complement bilingual communication. Language switching may be rule-governed and function-specific [Malakoff & Hakuta 1991 p. 146-7]. Language switching signals group boundaries, emphasis, role playing, sociocultural identity, the level of an interaction, and the level of intimacy or emotional charge. In fact, as Skutnabb-Kangas [1984 pp. 213-217] points out, language switching has been used to measure the extent of bilingualism.

Mercer, Rosen and Chapman [Open University 1988 pp. 16-17] refer to an English/Spanish conversation transcribed by Fishman [1971] and taped material in English and Kannada in a discussion of "*linguistic repertoire*". In the Spanish/English transcript languages are used for specific functions, Spanish for personal, Hispanic culture talk, English for business talk. The Kannada/English dialogue is less well defined. English words appear in Kannada sentences. Kannada constructions appear in English sentences. This is a step on the way towards the full diglossia of the transcript but signifies "*linguistic interference*". Full diglossia should provide the reader with code switching recognition skills which could be applied in reading school science textbooks, whereas students whose diglossia is incomplete might well find switches into and out of the science register confusing and difficult. In full diglossia, speakers select from their *linguistic repertoires* on the basis of the *function* of utterances, whereas in incomplete diglossia, speakers select from their *linguistic repertoires* on the basis of *what the hearer might understand*. The classroom use of scientific language is similar to diglossia in this respect. It is justified by the function of the text rather than by the language competence of the audience. Incomplete diglossia is akin to Lemke's "*hybrid register*" which is discussed in Chapter 3 (see 3.2.2). The author, whilst acknowledging that such a developmental stage probably exists, contends that the language of science classrooms is a mixture of language codes, each used for specific functions, like diglossia, rather than a hybrid form. He also argues that bilingualism may have an *additive* or *subtractive* effect on the understanding of scientific language.

1.2.8 Bilingualism and educational achievement

The "*underachievement*" of students from ethnic minority groups was regularly reported in the past [Figueroa 1984]. Townsend [1971] and Figueroa [1974, 1984 p. 120-121] found that ethnic minority students were under-represented in selective, academically oriented secondary schools and over-represented in the lower streams of schools which had streaming. Whereas 32% of Pakistanis were taking non examination courses compared with 3% of white British students, only 6% of Asians compared with 42% of white British were taking GCE O Level course [see also Townsend & Brittan 1972]. A smaller proportion of Asian students than white British got into University [Figueroa 1984 p. 125]. However, studies [Craft & Craft 1983, Dean 1994 p. 7] have also shown that almost 80% of Asian fifth form students from working class families stayed on in full time education while British students were well behind all other ethnic groups in continuing full time education. In 1985 the former Inner London Education Authority began to monitor examination results by ethnic background of students [Kysel 1988 p. 85]. Table 1.1 shows the results of the 1985 survey converted by a points system where an O-Level grade A is worth 7 points through to a CSE grade 5 at 1 point.

Table 1.1: Average performance scores

Ethnic group	Average perf score	n=
African	16.9	426
African Asian	22.7	162
Arab	14.0	891
Bangladeshi	8.7	333
Caribbean	13.6	2981
ESWI*	15.2	10685
Greek	17.6	243
Indian	24.5	398
Pakistani	21.3	231
SE Asian	19.1	300
Turkish	11.9	268
Other	21.3	940
ALL	15.6	17058

**English, Scottish, Welsh & Irish*

There is a clear variation in educational achievement. Bilingual students were both the highest and the lowest achievers with the highest achievers, the Indian students gaining nearly three times as many points as the lowest, the Bangladeshis. The British students achieved results which were average for the whole population. These findings may be evidence for a threshold theory of the effects of bilingualism. However, it might be that attitudes towards bilingual students and their own self image may be as, if not more, important than the benefits of bilingualism in educational achievement. Further work would be needed to sort out these inferences. The issue of educational achievement amongst ethnic minority students is complex. Poor showing on school selection, in setting arrangements and examination entries possibly reflects teacher stereotyping and prejudice. However, it would appear that Indian and Pakistani students, in particular, have high aspirations and the ability to succeed within the examinations system [see also Hofkins 1994a p. 6].

Sammons [1994] tracked the achievement of a large group of inner London school students from primary school, through secondary transfer, to GCSE results, (from 1980 to 1989). She investigated the effects of gender and ethnic and socio-economic background on achievement. Other studies have demonstrated the existence of differences in attainment from students with different social class backgrounds. Low income, large family size, one parent status and poor housing are also "*powerful predictors of academic achievement*". Inevitably, some of these factors are found in combination with one another and with other factors such as behavioural problems, fluency in English and ethnic background [Sammons 1994 p. 3-4]. The evidence for the effect of social class is more clear cut than that concerning gender and ethnicity [Paterson 1992, Riddell 1992, Gilborn 1992]. Although girls out perform boys at primary level and in overall examination performance at GCSE, there are important differences in subject entry and performance at GCSE and A Level. Girls are less likely to enter higher education [Sammons 1994 p. 5]. There is a wider variation in boys' performance [Goldstein 1995]. Sammons [1994 p. 5] reports research findings which show a trend away from underachievement in Afro Caribbean students. Nuttall [1990] demonstrated a significant difference in achievement between Bangladeshis and Pakistanis.

Sammons [1994 pp. 18-19] found that the effects of socio economic factors increased over the period of secondary schooling, and that gender differences "*remained* *marked in favour of girls*". However,

> "*the pattern of ethnic differences in GCSE performance had altered markedly from that identified in both reading and mathematics attainment during their junior education*"[Sammons 1994 pp. 18-19]

in favour of Asians and those of non-Caribbean origin other than British. Gilborn and Gipps [1996 p.41] discuss research in Lancashire and London [Thomas & Mortimore 1994 pp. 14-15, Thomas, Pan & Goldstein 1994 pp. 10-11], which shows that some ethnic minority students tend to make rather better progress than their white peers. Consistent with these findings, another study by Curtis and Millar [1988] found slight ethnic differences in language performance in early secondary school children in favour of the monolingual English which may indicate a transitionary phase. Curtis and Millar compared science performance in thirteen year old "*English and Asian language speaking students*". The study did not take gender or the difference in performance amongst Asian groups into account. Referring to science topics, they concluded that,

> "*many categories do not display any great differences between Asian and English children's patterns of responses*" [Curtis & Millar 1988 p. 71].

However, they claimed that Asian students experience more language difficulties than their monolingual English peers who had more "*scientific*" ideas and more familiarity with scientific language.

Sammons offers three possible explanations for these findings. One, that the style of assessment used in GCSEs, continuous assessment and coursework, favours girls and those from ethnic minorities. Secondly, that there has been a change in attitudes amongst ethnic minority students. Lastly, that there has been a real improvement in performance amongst these students. The factors which Sammons identified are unlikely to act independently and should be seen in the context of changes in society. The number of positive role models for girls and ethnic minority students such as MPs, television personalities, business managers and teachers has increased. Curriculum materials have, belatedly, followed this trend [e.g. NCCT 1992-94]. The real improvement in performance in ethnic minority students compared with the underachievement reported in earlier studies is consistent with the development of self esteem. The improvement in performance is concurrent with the trend towards multicultural policies in schools. One could also speculate that as ethnic minority communities develop into second and third generation British communities, rather than assimilating into the host culture, they may mature into bilingual cultures with a developing diglossia, leading to increased language awareness and advantage in understanding subject registers, the proposition developed in this thesis.

1.3 Text

Various media such as books, radio, television, film and spoken text constitute text. Texts contribute to many life experiences, information and misinformation. Halliday and Hasan [1976] describe a text as,

> "*a unit of language in use. It is not a grammatical unit, like a clause or sentence; and it is not defined by its size.*" [Halliday & Hasan 1976 p. 1].

Text should not be thought of as some kind of super sentence. It best described as a semantic unit, a unit of meaning. It is more "*realised*" by or "*encoded*" in sentences than "*consisting*" of sentences. The "*semantic unity of a text*" is expressed through the cohesion among the sentences comprising the text. The text will display a form of consistency defined as register [Halliday & Hasan 1976 pp. 2, 293-294] which embodies its relationship to its environment. Hodge and Kress [1988] relate text to discourse as,

> "*Text is the concrete material object produced in discourse*" whereas "*discourse refers to the social processes in which text is embedded*" [Hodge & Kress 1988 p. 6] .

In this research, the contents of a page of the Nuffield Co-ordinated Sciences Biology textbook [Chapter 5, NCCT 1988b] is considered to constitute the *relevant text*. For the sake of clarity written text and graphic text are referred to separately but it is assumed that these are parts of one entity, the *text*. Just as figures and tables are an important part of the *text* of a science textbook, changes in typeface, the use of parenthesis, the use of inverted commas and other forms of punctuation also convey important messages to the reader. These messages are considered to be part of the *text* within this research. It is also assumed, rather than restated, that the textbook operates within a network of classroom texts. Such classroom texts are written or spoken messages concerning the use of the textbook and perceived messages contained within it.

1.3.1 Textbooks

All books contain text, but this particular *genre* is distinct. A "*textbook*" is defined in the Concise Oxford Dictionary as,

> "*a book prescribed for study*" [Fowler & Fowler 1964 p. 1340].

Traditionally, such books are densely packed with information and, as Chrissie Maher of the Plain English Campaign has pointed out [Sanders 1995], are difficult to read. A recent survey [BSA 1996] found that 16% of secondary school students said that they have difficulty in reading course texts and textbooks. "*Prescribed*", rather than *useful, interesting* or *entertaining* gives the description of textbooks the right tone. They are books forced upon unreceptive audiences. Lynch and Strube [1983, 1985] argue that the general form of school science textbooks has hardly changed during this century and that many recent changes to the form are merely cosmetic. Sutton [1994 p. 11, 1996 p. 10] traces a sequence of three kinds of scientific publication showing the flow of scientific ideas.

Journal ⟶ Handbook of research ⟶ Textbook.

Although this model accounts for professional science textbooks, it should be applied with caution to school science textbooks. Most of the material in school textbooks is already enshrined in the Pantheon of science. School science textbooks are teaching resources rather than reference material and are usually written by professional teachers, who learnt from textbooks, rather than by professional scientists. The audience possess only limited scientific knowledge and understanding of the language of science. A more realistic flow diagram for these books would include a feedback loop.

Journal ⟶ Handbook of research ⟶ Textbooks ⟶ Teachers

Using his three step model, Sutton [1994, 1996 pp. 10-11] traces a logical, understandable, progression of language between the tentative journal and the more assertive, didactic textbook. This textbook retains some features of the journal such as some formal references to supporting research evidence. The journal language facilitates discussion between scientific professionals, the textbook language enables study. The school textbook model is far less tidy. There is a danger that the feedback loop has gone through so many iterations, involving so many textbooks, that the need for a particular language form is no longer clear to the author, teacher or reader and may simply follow a convention. Readers may not see the links with original research. This lack of defined purpose in textbook language may make it inaccessible to some readers.

Unlike newspapers, scientific papers and novels, textbooks are not autonomous. The Nuffield Co-ordinated Sciences Biology textbook [Chapter 5, NCCT 1988b] was published in conjunction with complementary Physics and Chemistry textbooks [NCCT 1988c, 1988d]Teachers' Guides [NCCT 1988a, 1992a], video material, worksheets [NCCT 1988e, 1988f, 1988g], teacher input, and other material. It is employed in a wide range of situations where classroom managers, teachers, decide its most appropriate use. Teachers adapt and integrate resources appropriately for each group of students. They might expect textbooks to be flexible resources covering a broad range of classroom needs including language and multicultural needs.

1.3.2 Transmission and constructivist models

Textbooks play different roles in different classrooms depending on the philosophy behind the teaching and learning taking place. In the *transmission* model, a body of knowledge is transferred from teacher to student. Such a teacher might say '*If you know everything in this textbook you will pass the exam*'. The book is to be learnt. A *constructivist* approach emphasises the student's own development in a subject. In this case the teacher facilitates the student's learning by creating appropriate learning situations and then guiding the process through well timed *interventions*. Here the textbook might serve as a source of information for student's learning and assimilation into their own structure for knowledge. The constructivist approach acknowledges that a student's understanding of concepts develops over a period of time until the next session of teacher input which builds on prior learning. The transmission approach assumes that the student's understanding remains static until the next bout of instruction when prior knowledge is laid aside. Although the extremes exist, the activities taking place in most classrooms fall somewhere between these two models. Good teachers vary approaches to suit circumstances. The textbook is likely to be used for homework, a situation where the student is unlikely to have access to either an expert to answer factual questions, or a facilitator to guide learning.

The two approaches require different textbooks. The transmission model seeks explicit information laid out in an easily assimilated form. Questions test that facts have been learnt and reinforce an imposed structure for knowledge. The constructivist model might require some information to be more implicit, presented in a facilitating format. In this case the textbook should generate further questions of the student. Questions promote the construction of a personal structure for knowledge. However, both approaches require the restatement of concepts learnt previously at a new, higher, level of understanding.

1.3.3 Alternative media

As Solomon [1987 pp. 75-77] and Lucas [1983] have pointed out, students encounter and learn about science, through a range of language based media other than science textbooks. They learn both in school and through less structured experiences outside school. Television, museums, CD-ROM, comics, newspapers and conversations with informed adults, contribute to students' understanding. These media may support the work of teachers and textbooks or they may seriously undermine it . In many cases alternative understandings and meaning makings are far more vivid to students than textbooks. They may be reinforced through repetition and association with enjoyable activities and exciting images. Above all, they are engaged voluntarily.
Consequently, they may contribute to sophisticated "*alternative frameworks*" [Driver 1981] which, as Jones [1995] points out, are difficult for teachers and textbooks to displace. On the other hand, supplementary experiences may reinforce ideas or explain them in a more accessible way. Unfortunately, some *popular* science

presenters such as David Attenborough may reinforce stereotyped notions of scientists as white, middle class, males, authoritative figures presenting information for assimilation rather than for debate and re-interpretation. Jones [1995] reports that television viewers often complain of difficulty with the scientific language used in such programmes.

1.3.4 Text and context

Halliday and Hasan [1989] describe the relationship between text and context as,

> "*The text creates the context as much as the context creates the text. Meaning arises from conflict between the two.*" [Halliday & Hasan 1989 p. 47].

They [1989 pp. 6-7] describe two kinds of context in relation to text, the "*context of culture*" and the "*context of situation*". The relationship is "*dialectic and bi-directional*" rather than "*deterministic*" [Halliday 1991 cited in Winser 1994 p. 18]. The context of culture includes assumptions on the part of the author about the cultural experience of the reader. The context of situation involves the relationship between author and reader implied by the text and the relevant features of the situation and circumstances of the reading. Both may have important implications for bilingual readers. Text in context is explored further in Chapter 2 which examines issues concerning textbooks in use in science classrooms and Chapter 3 which deals with linguistic aspects of science textbooks in context.

1.4 Summary

Student bilingualism was treated as a classroom resource. The resources which students bring the classroom are discussed further in the next chapter which deals with pedagogical issues related to the use of school science textbooks. A possible explanation for the relationship between bilingualism and the understanding of science text was put forward. This argument is developed further in Chapter 3 which deals with the language of school science textbooks and classrooms. The nature of texts and textbooks were briefly reviewed and the importance of context in understanding the meaning of texts was outlined. The nature of texts and the relationship between text and context text is a recurrent theme of both Chapter 2 and Chapter 3.

Chapter 2: Reading, learning and school science textbooks

2.1 Introduction

School science textbooks are written for a particular function. Alongside other spoken and written texts, they contribute to the education of students. The role of school science textbooks specifies the contexts within which they are used, including the social relationships between student, teacher and textbook author. Work in science can be made intelligible by context and through practical tasks and activities and learning should not depend on competence in English [Runnymede Trust 1993 p. 46]. This chapter examines pragmatic issues concerning the use of texts for teaching and learning in science classrooms, focusing on school science textbooks. It covers the institutional and cultural environments and deals with the "*context of situation*" and "*context of culture*" [Halliday & Hasan 1989 pp. 6-7]. The context and text issues related to bilingual access which were raised in Chapter 1 are developed in preparation for discussions of the language of school science textbooks (Chapter 3) and an exemplar textbook (Chapter 5).

The chapter first considers differences between what are identified as *uncodified* spoken text and *codified* written and graphical text. The discussion of codified text is developed, first at the level of decoding the information on the printed page, then as text comprehension of "*micropropositions*" and "*macropropositions*" [Meyer 1985 pp. 15-20]. Understanding at the text structure and schema level and information management within teaching and learning are also covered. As the medium of expression and means of scientific thought, scientific language is closely linked with the relevant *schema* and information management. The notion of schemas is introduced near the beginning of the chapter and links the main themes, comprehension, prior knowledge, study skills and context, together.

2.2 Spoken and written language

There are important differences between spoken English and written English. Amarel [1982 p. 244] discusses Olson's view that written language is not just preserved speech, it has distinct attributes of its own. In speech, meaning is constructed from a combination of linguistic and non-linguistic cues. Written language is more dependent on cues embedded in itself, it is decontextualised. Consequently, written texts are more rule governed and are thus conventionalized. Amarel [1982 p. 245] also considers Vygotsky's conclusion that oral and written language are distinct linguistic forms, each with its characteristic functions, structures and developmental trajectory.

Stubbs [1983] points out that formal written English (i.e. Standard English) contains a wide range of "*connectors*", words like, *and, but, if, since, whereas, however* and *nevertheless*. There is,

> "*a much narrower range in conversational English: and, but and if are the commonest, and therefore have a wide range of functions.*" [Stubbs 1983 pp. 81-82].

Stubbs argues that Bernstein [1971 pp. 47 & 157] did not consider this, and other differences between spoken and written English, when he characterised his "*restricted code*". There is a difference in logical power and stylistic preferences between spoken and written English. Written English, in general, uses a wider range of lexical synonyms [Stubbs 1983 p. 82, Gazdar 1979]. Writing is less redundant and repetitious than speech because it can be read and reread. Written text is organised as sentences whereas speech is generally complexes of clauses [Kress 1982 cited in Edwards 1984 pp. 88-89]. The two forms are complementary [Halliday & Martin 1993 pp. 118-120]. Halliday [1985 p. 87] argues that whereas written language is static and dense, spoken language is dynamic and intricate. "*Grammatical intricacy*" in speech replaces "*lexical density*" in written text. Parallel principles apply to graphic text. In everyday language we are mainly concerned with "*motifs*" [Halliday & Martin 1993 p. 113].

> "*We behave as if the metaredundancy - the realisation in the lexicogrammar - is simply an automatic coding.*" [Halliday & Martin 1993 p. 113].

Modern technologies blur the distinction between spoken and written language [Halliday & Martin 1993 p. 21].

2.3 Reading, interpretation, comprehension and schemas

Despite pronouncements to the contrary [Blackburne 1995b], Brooks, Foxman and Gorman [1995] have shown that reading standards among children leaving primary and secondary schools have hardly changed since 1948. The development of audio and visual means of communication during this period led to a reduction in the importance of written text as a means of transmitting information. Consequently reading habits and people's needs in reading have changed. These changes may have led to the pronouncements mentioned above. There may have been more emphasis on comprehension than on interpretation in the past. This author considers interpretation to be as important as comprehension in reading a text. Comprehension implies the understanding of the author's intended meaning, whereas interpretation implies the reader's creation of meaning through comparing the text with their own experience. Inevitably, readings are a combination of comprehension and interpretation.

Osborn, Jones & Stein [1985 pp. 10-11] describe "*schemas*" or thought structures within which readers makes sense of different types of text. Schemas are developed through experience and are important to understanding. They provide "*ideational scaffolding*" for assimilating ideas and a basis for sifting information. They facilitate inference, elaboration of meaning, editing, summarising and the bridging of gaps in memory and knowledge. The science textbook schema includes scientific language and cultural knowledge and consequently interacts with bilingualism. The value of such resources which students bring to classrooms and textbooks is a recurrent theme throughout this thesis. As a result of the effects of linguistic and cultural history, the only person capable of reading text exactly as the author intended is the author at the moment of writing. The author changes with time and experience (including writing the text) and becomes distanced from their own meaning in text. This lack of spontaneity, reader/listener interaction and environmental context, distinguishes written texts from spoken texts.

2.3.1 Reading development

Perera [1984 pp. 278-279] defines three phases in reading development, preparation, consolidation and differentiation. The preparation phase involves learning to recognise letters and words. Reading ability catches up with oral language ability during the consolidation phase. Many readers fail to reach the third phase where reading comprehension outstrips auditory comprehension. At this point, as Perera [1984] observes, the

> *"processing of difficult language and ideas actually becomes easier for the reader*

than for the listener;" [Perera 1984 p. 279].

On average, progress to the third phase occurs at thirteen . Students still at the consolidation phase have difficulty with constructions which are found more often in written, than spoken, English [Perera 1984 pp. 288-302].

The skilled reader can read much faster than the normal rate of speech. Together with the facility to scan backwards and forwards within the text, this aids understanding of grammatical relationships. Perera [1984 pp.279 -280] presents evidence to show that the average reading rates of 14-16 year olds are still well behind adult reading rates. Perera [1982b p. 127] explains that the good reader can keep enough of the meaning in their short term memory to make sense of it and know how and when to vary their style of reading. Although to encourage fast reading can be counterproductive, as Lunzer and Dolan [1979 p. 63, 76], Rothkopf [1982 p.129] and Singer [1982 p. 144] point out, it is possible to show poor readers how to be flexible with reading style. Skilled readers use self monitoring, remedial activities, self questioning and rereading. Osborn, Jones and Stein [1985 p. 11] explain that immature readers make less use of relevant prior knowledge and are less able to sort out the relevant from the irrelevant within a text.

2.3.2 Patterns of reading in science lessons

Research carried out as part of the *Effective Use of Reading Project* [Dolan, Harrison & Gardner 1979 p. 125] showed that the pattern of continuity in reading in class is very intermittent. Year 10 students' reading in science tended to be in "*short bursts*". 57% of the reading recorded occurred in periods of between 1-15 seconds during any minute of observation, and a further 36% was in periods of 16-30 seconds. In all, 93% of the time spent reading was in these short bursts. As Carré [1981] points out,

> "*Pupils doing this short burst reading are not developing skills related to reading for learning, nor are they exercising critical reflective or evaluative approaches.*" [Carré 1981 p. 81].

Gardner [1979] explains individual differences in reading comprehension as,

> *"differences in the willingness and ability to reflect on what is being read"* [Gardner 1979 p. 300].

The short bursts strategy reflects classrooms where the purpose of reading is seen in tasks such as reading questions from a textbook, workcard or blackboard before answering, or copying key phrases from a textbook [Carré 1981 p. 81]. It appears that, as Nelson [1978] points out,

> *"Subject area textbooks are not designed for independent reading."* [Nelson 1978 p. 625].

Cole and Lunzer [1979 pp. 145, 150] found that majority of the science homeworks which they studied as part of the Effective Use of Reading Project were concerned with answering questions on text. This approach may encourage the same short bursts reading strategy as students employed in the classroom.

2.3.3 Gender, leisure reading and other activities

Gender should be a consideration in a study of the accessibility of school science textbooks to bilingual students. The view of the role of women in some ethnic minority communities differs from that in the majority community and affects attitudes towards the value of education for girls in those bilingual communities [Sutcliffe 1995, Hugill 1995]. Various studies [e.g. Grant & Harding 1987] have shown than in the general population there is a difference between boys' and girls' perception of science as a worthwhile activity and a marked difference in girls' and boys' reading habits. One might expect this trend to be more noticeable in some bilingual communities with conservative attitudes to the roles of men and women in society.

Concern about girls' underachievement in, and lack of uptake of, science courses has been expressed in the National Curriculum Non-Statutory Guidance and by leading academics [NCC 1989 pp. A9, A10, BBC 1995]. According to Lapointe, Mead and Phillips [1992] girls' underachievement in, and lack of uptake of science courses is an international problem. International concern about boys' poorer performance in literacy skills and language based subjects is also reported [Klein 1995a]. In a recent survey of 13,000 students [Budge 1995a], girls did better than boys at GCSE in all subjects except Mathematics. Smithers and Robinson [1994 pp. 7-8] showed that the Double Science courses discussed in Chapter 5 (see 5.2-5.2.3) and the National Curriculum for Science have increased girls' participation in physics and boys' participation in biology with girls achieving slightly better overall standards.

White [1991 p. 181] writes that despite an apparent equality of provision, boys and girls tend to be literate in different ways and with different degrees of proficiency. Girls read for pleasure more than boys [Pratt, Bloomfield & Searle 1984, Dean 1993, Budge 1995b]. White [1991] quotes Assessment of Performance Unit research [Gorman et al 1981] to show that in primary age students,

> "*boys rather than girls have clearly developed interests in a range of "hobbyist magazines"... [...] girls are, in general more avid readers*" . In secondary age students, "*these differences are accentuated*". Boys prefer "*accurate facts about hobbies or how things work*", whereas girls read "*to help understand other people's problems such as those to do with love, sex and marriage*" White [1991 p. 183].

Various authors [Whyte 1986 pp. 15-24, Catton 1985 pp. 21-28, Clegg & McCormick 1988 pp.21-29, Heather 1983 pp. 132-133, Gorman et al 1991 pp. 54-55], describe how such stereotypes are reinforced by parents, family, media (particularly in advertising) and unfortunately, by some teachers. Surveys of sex bias in textbooks [Smail 1985 p. 35-36, ILEA 1986 p. 20], showed women in passive and traditional roles with pictures of males outnumbering females by up to three to one.

Table 2.1 shows the differences between boys' and girls' hobbies. Although Music has equal standing with both genders, reading is missing from the boys' list altogether. Boys are interested in Sport, *how it works*, mechanical toys and measuring instruments [see also Stobart, Elwood & Quinlan 1992 pp. 8-11, Murphy 1991]. It appears that girls' interests are more aesthetic.

Table 2.1: The ten most popular boys' and girls' hobbies

Girls	**Boys**
Swimming	Football
Cooking	Sports
Music	Music
Dancing	Youth Club
Knitting/sewing	Swimming
Youth Club	Cycling
Reading	Fishing
Art/drawing	Cars
Horses	Motorbikes
Ice skating	Model making

Source : [Catton 1985 p. 180]

A study of 15,000 teenagers [Page & Nash 1980] found that,

> "*Fourth year secondary school boys are far more positive in their attitudes to technology and industry than girls*" [Clegg & McCormick 1988 p. 24].

The GATE (Girls And Technology Education) [Grant & Harding 1987] study concluded that boys were more likely to see science and technology as beneficial to the human race whereas girls tend to express doubts about their advantages and consider science and technology harmful to humans [Clegg & McCormick 1988 p. 25]. This finding has important implications for issues, context and relevance in science education that are discussed later in this chapter (see 2.6.3-2.6.4). Stark and Gray [1995] observe that,

> "*Girls are more likely to participate and succeed where the emphasis is on active, investigative learning which includes a consideration of the relevant social and political issues*" [Stark & Gray 1995 p. 3].

Gipps [interviewed by Pyke 1996 p. 8], says that "*girls pay attention to and value context*", whereas "*boys prefer to learn things abstracted out of context*". She points out that girls prefer narrative presentation, boys graphical presentation. White [1991] observes that,

> *"there is more coincidence between the themes of girls' preferred reading and courses in English literature". "There are similarly direct links between the technical reading consumed by boys and the scientific/ mathematical areas of the curriculum"* White [1991 p. 183].

Boys' self directed reading is increasingly associated with computers, graphics, tables and symbolic displays [EOC 1985]. These findings are supported by evidence from a national survey relating students' leisure interests to their takeup of science subjects [Johnson & Murphy 1986] and research into students' writing [White 1987]. Solomon [1988 pp. 44-45] produces some evidence to show that the extent of these effects may be related to students' community and cultural backgrounds. White [1991 p. 185] suggests gender differences in accessibility to science text. Biology text may be more accessible to girls than physical science text. It has built-in context and issues.

2.3.4 Cohesion and coherence in text

As Chapman & Louw [1986 p. 9, see also Halliday & Hasan 1976] explain, a text *"functions as a unity with respect to its environment"*. They describe two aspects of unity in texts, internal unity or cohesion and unity in relation to their context of situation or register. Cohesion in text,

> *"enables the reader to integrate parts of the text so as to remake the author's meaning."* [Chapman & Louw 1986 pp. 9, 17].

"Cohesive ties" [Halliday & Hasan 1976 pp. 3-4, Tierney & Mosenthal 1982 pp. 69-79] are linguistic features which contribute to the global cohesion of the text. For instance, a pronoun like *they* has its place in the order of words or Halliday's [1994 pp. 38-40] *"theme-rheme structure"*. Chapman and Louw [1986 p. 18] point out that it is also cohesively related to the noun it stands for. Halliday & Hasan [1976, see also Anderson 1983 p. 87, Halliday 1983] discuss five forms of cohesive tie within text, reference, substitution, ellipsis, conjunction and lexical cohesion. As Williams

[1983 pp. 116-117] points out, readability improves if cohesion and coherence are "*strengthened*".

Perera [1982b pp. 130-132] and Davies 1986 [p.104] explain that text is more than the sum of its words and sentences, it has an overall "*meaning structure*". Various authors [for example, Davies 1986 pp. 104-107, Kintsch & van Dijk 1978, Brewer 1980] have shown that words and sentences are linked in chains and networks, consistently related in terms of meaning. Cohesion and coherence have an important contribution to make to whole sentence and whole text meaning. Roller [1986 p. 57] points out that clear cohesion and coherence facilitate readers' understanding. Repetition and pronominalisation of nouns are important factors in the establishment of cohesion [Perera 1986 p. 58, 1984 p. 320, Halliday & Hasan 1976 pp. 277-282]. In advocating a reading strategy of "*paragraph reading*" for English as a second language students, Leonardi [1981] found,

> "*that among cohesive ties, conjunctions- let us call them sentence connectors- prove especially relevant.*" [Leonardi 1981 p. 165].

She explains that foreign readers find these "*illuminated signposts*" helpful. They provide "*sense relationships*" between sentences and enhance reading efficiency. Bensoussan [1990 pp. 22-23] explains how her English as a Foreign Language students in Israel depended on an understanding of the cohesive features of a text in order to make sense of it.

Perera [1982b p. 131, Gardner 1977] reports that when 15 year old secondary school students' understanding of about 200 of the connective words used in scientific writings was tested, three of the words including *moreover* were understood by only 30% and eleven of them by only 50%. She [1984 p. 277, 1986 p. 58] also points out that "*interrupting constructions*" between subject and verb and ellipsis, which are typical of non-fiction texts, cause reading difficulties. Ellipsis and substitution of words by superordinate terms are characteristic cohesive features of science text affecting density and redundancy. Myers [1991 pp. 7-22] includes difficult synonyms, oppositions, superordinates and dominance relations in a list of difficulties with science text for the non-specialist reader. He also explains how experienced readers use the cohesion in text to infer meaning by induction and metaphor and refers to the link between text cohesion and "*knowledge*" [Myers 1991 p. 3]. This aspect of cohesion in text also links with text schema.

2.3.5 Visual and graphical literacy

Winn [1987 pp. 156-157] describes "*Visual argument*" as expressing ideas, points of view and solving problems graphically rather than linguistically . "*Visual literacy*" as described by Goldsmith [1984 p. 68] and Kress and van Leeuwen [1990 pp. 2-22] is the idea that "*we have to learn to "read" pictures*". Levie's [1987 pp. 19-20] literature review suggests some success for instruction in this area. Goldsmith [1984 p. 409] traces the development of pictorial perception to completion at about age 12. The development of "*visual literacy*" and "*visual perception*" are stated aims of the National Curriculum for Art at Key Stage 3 [DFE 1995 p. 2]. A complementary concept is Fry's [1981] "*graphical literacy*", which he applies to flowcharts, bar charts and pie charts, scientific diagrams, pictures and photographs. This form of communication predates written verbal language and is a set of skills which can be taught [Fry 1981 pp. 383-385, 389, Wright 1981 pp. 61-69]. The nonverbal, nonsymbolic nature of graphs does not make them *culture free*. Students must learn to comprehend and create graphs [Fry 1981 p. 390]. One might expect that the longer bilingual students have been exposed to western culture, the closer their responses to pictures are likely to be to those of their monolingual peers. By fourteen they should have developed visual and graphical literacy and any inaccuracies in interpreting scientific figures should be due more to problems with scientific conventions, which may have a cultural element, than to general cultural differences. Instruction in the interpretation of scientific illustrations would be of value to all students.

2.3.6 A "grammar of graphic representation"

Kress and van Leeuwen's [1990] "*grammar of graphic representation*" or "*grammar of visual design*" [1996 pp. 3-4] is a useful tool in the analysis of figures. Newton [1993] points out that tables take,

> "*advantage of the way we read from left to right (in the West) and from the top to the bottom of the page*" [Newton 1993 p. 66].

When spatial layout is used to show process or structure,

> "*In a sense, the elements are treated like nouns and the arrows like verbs so that the diagram makes a sentence-like statement*" [Newton 1993 p. 66].

Kress and van Leeuwen [1996] stress that students need a full understanding of this grammar to understand the message of figures. It is culturally specific and is learnt. Students' need to *read* the information contained in pictures [Constable, Campbell & Brown 1988 p. 90], layout [Goldsmith 1987 pp. 71-82] and the relationships between the parts depicted [Brody 1981]. Constable, Campbell & Brown [1988 p. 90] explain that student and teacher must agree on the information contained in illustrations as well as written text. They divide theories of picture interpretation into, "*likeness with the object represented*" [Wittgenstein 1961], or "*arbitrary symbols and conventions*" [Arnheim 1969]. The second notion is more useful when considering scientific illustration. Kennedy [1974] observed that this concept concerns the development of a vocabulary of pictorial symbols and conventions. Holliday [1973] and Constable [1983] point out that school science texts use a great deal of "*highly conventionalised illustrations*". Constable, Campbell & Brown [1988 pp. 100-101] showed that cross sectional diagrams, which are characteristic of biology texts, cause students problems. This finding reveals three fundamental problems with representation in biology. First, that the three dimensional structure of the objects depicted is important. Secondly, that important structures inevitably contain other structures which are also important. Thirdly, that the shapes depicted are unique and cannot be visualised by reference in the student's mind to a pre-existent library of standard shapes. Students should be taught about this grammar of scientific graphic illustration along with picture scanning strategies, including means of interpretation.

2.3.7 Non linguistic features of written text

It was pointed out in Chapter 1 that text is more than the words on a page (see 1.3). As Gropper [1988] points out, it includes typefaces, paragraphing and layout which also contribute to accessibility. Harrison [1980b p. 16] explains that various aspects of typography determine how easily letters and words can be deciphered including size of type and font, layout and line length. Reid, Beveridge and Wakefield [1986] looked at the effect of colour in pictures in textbooks. They compared the effects of monochrome and colour copies of identical photographs. They concluded that whilst colour increased the quantity of observations amongst their subjects it did not increase the quality of those observations.

> *"Students are sometimes distracted from the scientifically more important features of shape, size and texture by the presence of colour."* [Reid 1990a p. 167, see also Goldsmith 1987 p. 63].

Harrison [1980b p. 19] points out that black ink on purple paper is the least legible combination, black on white being, by far, the best. Headings are vital signposts within the text for less confident readers. Burnhill & Hartley [1975 p. 66] consider it debatable whether overprinting on dark backgrounds helps the reader by making the heading stand out, or hinders because it is more difficult to read than black on white, the legibility depends on the reflectance of the paper.

2.4 Figures in school science textbooks

The figures included in a textbook play a role in the explanation, contextualisation and illustration of the written text. Their role and their impact on the reader were given careful consideration in this study because some of the textbook authors and teachers interviewed [e.g. Turvey 1993, Appendix A School 1018] suggested that some bilingual students may depend on figures in understanding written text. Holliday, Brunner and Donais [1977] showed that *"picture-word"* flow diagrams worked better than *"block-word"* flow diagrams in science text, especially with students who have problems with language.

Reid [1990a p. 161] suggests that learning from text in biology is enhanced in the presence of pictures. However, Holliday [1975] is less enthusiastic about the contribution made by pictures in school science texts. Various authors [Goldsmith 1984 pp. 17-23, Levie 1987 pp. 15-16, Dwyer 1978, 1982-83, Peeck 1987 p. 139, Holliday 1973] discuss Dwyer's [1972] work involving High School students aged 14 -16 using biological material. Dwyer found that the effectiveness of pictures depended on educational objectives and methods of presentation (group work or individual learning). He concluded, that gender and the size of pictures had little effect on learning and that colour had a variable effect. Bluth's, [1981 pp. 257-258] brief review of the research, was also less conclusive than Reid's. Levie and Lentz [1982 p. 203] reviewed five studies involving science and fourteen to sixteen year olds which closely simulated classroom conditions. These studies showed a significant advantage for illustrated text. One might conclude from this brief survey of research in the area that the value of figures in school science textbooks depends on the way in which they are used in the classroom.

Goldsmith [1984] discusses figures from the graphic artist's perspective. She concludes that,

> "*predictability of layout is an important factor*". "*Natural scanning tendencies can be exploited to facilitate cross referencing between text and pictures*" [Goldsmith [1984 pp. 403-404].

In a display containing both text and pictures, the pictures attract attention first. The eye moves from left to right in a horizontal display and downwards in a vertical display.

2.4.1 The picture superiority effect

Reid [1990b p. 252] describes a *Picture Superiority Effect* or PSE for learning tasks involving recognition memory. Reid and Beveridge [1986, Reid 1990b pp. 253-254] looked at differences in learning from pictures, including a case where pictures were withdrawn altogether. They concluded that the mere presence of pictures does not have a general "*facilitating*" or "*motivating*" effect and that only pictures which contained specific information already included in the text were involved in the PSE [see also Levie & Lentz 1982 pp. 224-225]. Waddill et al [1988] point out that only "*appropriate*" pictures result in a PSE and Terry and Howe [1988] explain that too many picture adjuncts interfere with learning from text. These findings are consistent with Barthes' view [1967, 1977,Kress and van Leeuwen, 1990 pp. 3-4] of the relationship between written texts and images. Levie and Lentz [1982 pp. 225-226] and Bluth [1981 p. 255] show that although figures will not facilitate the learning of text not illustrated by them, they do aid understanding and memory and perform other instructional functions. They also point out that some learners will not make use of complex illustrations unless prompted to do so.

Some reseach [Bluth 1981 pp. 255-256, Reid & Beveridge 1986, 1990 p. 76] shows that pictures enhanced comprehension in good readers but not poor readers. This contradicts other studies [Levie & Lentz 1982 p. 226, Koran & Koran 1980 pp. 480-482]. Goldsmith [1984 p. 71] argues that when pictures are not essential they have a levelling effect, helping slow learners and retarding others. Reid, Beveridge & Wakefield [1986] indicated an interaction between ability and the form of pictures. Students of high and low ability observed more items from photographs than line drawings whereas students of medium ability did not. These findings suggest that the photographs motivated the less able. Several studies [Peeck 1987 pp.135-137] show improved responses to illustrated text in poor readers. When illustrations replace verbal treatments, less able readers are helped. However, increased realism helps able students more than the less able. Winn [1987 pp. 172-173] concludes that the extra information stretches cognitive capability.

2.4.2 Cultural factors

Reid [1990a p. 169] presents evidence to show that cultural background affects picture perception. Chaplin [1971], Hudson [1967], Jahoda & McGurk [1974] have shown that cross cultural differences involve perspective, depth perception and the interpretation of symbolism in photographs and graphics. However, Jahoda & McGurk [1974], and Goldsmith [1984 pp. 206-210] found that problems of recognition of photographs and two dimensional representations by Africans are no longer as great as they appeared to early observers such as Hudson [1960], since there are now few Africans who have no experience of such material.

> "*The extent of the difficulty is dependent on age and education.*" [Chaplin 1971 p. 79].

Sinha and Shukla [1974] demonstrated that deprived Indian children scored lower on tests of depth perception than average Indian children. As educational standards improve there should be an increase in visual literacy in these situations. In Britain, some students who have recently arrived from overseas may lack visual literacy and cross cultural differences in interpretation of symbolism may be a factor in bilingual students' interpretation of highly symbolic scientific diagrams as discussed later in this chapter (see 2.6.3).

Pettersson [1982] offers an environmental/evolutionary explanation of why black people like bright colours including the observations from African publishers that,

> ""*European books are so colourless". "Our children prefer pictures with bright, lively colours." "We prefer drawings to colour photographs. Photographs have too little colour." "Drawings are better. Then we can have the colours we want.*"" [Pettersson 1982 p. 50]

In this country, school textbooks generally selected and purchased by conservative, middle class, intelligent Europeans, are used by students with a wide range of abilities and cultural backgrounds [see also Holliday 1973 p. 207]. It is easier to solve the question of cultural preferences in book illustration in a monocultural non-European environment, than in the predominantly European, yet multicultural, environment prevailing in many British schools. Publishers tend towards conservatism in a competitive educational market where even a modest textbook venture involves the investment of several hundred thousand pounds [Pevsner 1993]. Recent developments, including educational publishers going out of business [see Book Trust 1992 pp. 51-55] and cuts in educational spending on books [see Fisher 1995, Book Trust 1992 p. 56-60, 1996 pp. 7-11] have exacerbated the situation.

In a cross cultural study conducted in Scotland, India, Ghana, Kenya and Zambia, Jahoda et al. [1976 pp. 313-314] found that when one mode (text or pictures) was used on its own, information presented as pictures was learned with equal effectiveness as the same information presented as text, in all the cultures examined. There was no cross cultural difference in learning from pictures. From earlier studies [Hudson 1967, Jahoda & McGurk 1974] they had expected the Africans to be less efficient at learning from pictures. When the information was presented in both modes, information presented in pictures, but not referred to in the text, did not seem to be learned at all. The redundant presentation of material in pictures and text produced better learning than single mode presentation in all the countries studied.

2.4.3 Photographs, drawings and cartoons

Photographs have the advantage that they are less bound by symbolism and convention than drawings or cartoons. However, the image is specific and limits the range of images that a viewer can create from it in their mind. Line drawings can be made *culturally neutral* (e.g. *Pathways Through Science* activity sheets [NCCT 1992-94]). Barlex and Carré [1985 pp. 38-45] advocate the use of cartoons and comic strips in school science materials in order to make an impact on students and to present information in a familiar form. However, they admit that this approach can mislead and reinforce misunderstanding and that the imagery may distract from, or trivialise, the science. These problems can be overcome by effective teaching. Of more concern is the stereotypic imagery typical of cartoons. Research [Sewell & Moore 1980 pp. 40, 45-46, Peeck 1987 pp. 140-141, Goldsmith 1984 p. 23] shows that although cartoons make learning more enjoyable, they do not lead to better comprehension. However, Sewell and Moore [1980 pp. 40, 45] found some evidence for the notion that females notice visual imagery more than males, who tend to rely on textual content. Keogh and Naylor [1995] point out that childlike drawings (as distinct from polished, professionally drawn, cartoons) present questions and alternative explanations for investigation and discussion in an accessible, non-threatening way. In the author's experience this is a technique used effectively by many teachers.

2.4.4 The role of figures

Pictures can be a useful addition to instructional text. Pictures make text look attractive. Well presented pictures can make a contribution to comprehension and learning. Harrison [1980b p. 19] and Wright [1981 p. 64] advise that information set out in pictures and tables should also be presented in written text and the links between the two modes should be clearly explained. As Wright [1981 p. 64] points out, readers are reluctant to stray from the point of reading . Page layout is another factor in the success of picture use in text. Goldsmith [1984 pp. 405-410, 412-420, 2.3.5] describes cross cultural differences in picture perception depending on *visual literacy* which probably exist but are of limited importance to this research study dealing with multicultural British Schools. Brody [1981 pp. 97-99] criticises much of the research reviewed above, arguing that it addresses the wrong question, asking "*whether or not pictures help*" rather than "*how they help*". In his opinion research perspectives should consider the "*context of pictures*", "*the instructional setting*", "*instructional intent and purpose*", "*thinking strategies*" the "*relationship between picture type and subject matter*" and "*learning*" other than "*the replication of knowledge*". Levin, Anglin & Carney's [1987 pp.73-77] "*Ten commandments of* *picture facilitation*" is a useful summary of these points.

2.5 Print as a medium of instruction

Carroll [1974 p. 152-153] points out that print is "*frozen language*" [see also Halliday & Martin 1993 p. 118]. It is no substitute for direct experience. However, as various authors [Carroll 1974 p. 154, Thelen 1984, Guthrie 1984], have shown, there are limits to the amount of direct experience possible in educational settings. Most direct experience is interpreted in some kind of symbolic form. Written language aids the student by presenting such symbolic forms in a prestructured arrangement. Carroll [1974 pp. 156-157] explains that the selective nature of language gives it an advantage over direct experience in that it enables the teacher or writer to focus the learner or reader's attention. Written text enables the learner to deal with information more quickly than direct experience or spoken discourse [Carroll 1974 p. 159]. Selective strategies such as skimming and scanning can be used with print. Material can be reprocessed as many times as is necessary and is constantly available [Carroll 1974 p. 172]. Many writers [e.g. Kress 1992, 1993] point to the replacement of written text by graphical iconic forms. However, as Carroll explains, these are often used to overcome the lack of universality in language rather than to replace it altogether.

Unless the object of study is printed text itself, it cannot replace direct experience. However, it can provide a variety of experiences which are often more effective and usually less expensive. It can annotate or guide direct experience [Carroll 1974 p. 172]. Print is a very good medium for presenting facts and information amassed by others. However, the learner needs direct experience in handling such information. Print is also useful where the learning involves understanding complex concepts and relationships. Print is less effective when the learning objective is a skill involving people or things such as learning to play the piano. Similarly, print falls down in the learning of algorithms and procedures which require constant feedback and reinforcement [Carroll 1974 pp. 176-179].

2.5.1 Reading to learn

Hart [1980 p. 61] and Friend, Karsch and Siegal [1989 p. 453] discuss the importance of reading in learning science. In fact,

> "*reading about science has an important part to play in scientific activity at all levels.*" [NCC 1989 p. F3].

Tonjes [1986 pp. 68-85] makes the important distinction between *learning to read* and *reading to learn*. As Perera [1986 pp. 53-66] points out, science textbooks require different reading strategies from the fiction which is much more familiar to students. Several authors [Davies & Greene 1984, Perera 1986 pp. 62-66, Tonjes 1986 pp. 70-74, 1993, Gilbert 1973 p. 747] have made a strong case for science teachers to provide more structured activities and strategies in reading for learning. Kang [1994] explains the value of such strategies to students whose first language is not English. In a review of recent research in this area (23 studies conducted between 1986-1990) Guzzetti, Snyder and Glass [1992] found that activities which activated prior knowledge, texts which refuted misconceptions, and discussion web activities, were the most successful strategies effecting conceptual change. Discussion webs, where students discussed the text in groups and reported back to a class discussion was the most effective strategy with high school students [Guzzetti, Snyder & Glass 1992 p. 647]. Davies [1986] compares the textbook with the teacher as a source of information in the classroom and comes to the conclusion that each has its advantages and disadvantages. They should be complementary. She also outlines a "*language model*" function for textbooks,

> "*in providing examples of particular genres and registers for pupils sensitive to varieties of Standard English. [...] ... but it cannot bridge the gap between these forms and pupil language.*" [Davies 1986 pp. 102-103].

Davies [1986 pp. 103, 108-109] explains that the textbook acts as a source of information of different kinds but it cannot control the processing of that information and discusses various active and passive ways of using textbooks both as a source of information and to teach students to learn how to process information. Halliday [Halliday & Hasan 1989 p. 45] refers to the experiential, logical, interpersonal and textual aspects of learning through reading a textbook. He explains the importance of understanding of the "*functional organisation of language*" in the successful reading of textbooks. Organisational aids such as advance organisers, headings, questions [Britton, Glynn & Smith 1985 pp. 227-229], pictures or diagrams [Glenberg & Langston 1992 p. 149], lists and tables [Gropper 1988 pp. 16-17], assist *load* *control*, releasing cognitive processing capacity for other aspects of the comprehension process. It is not surprising that in a recent review of the relationship between knowledge and text structure, Roller [1990] concluded that coherent structure facilitated comprehension, particularly when the content was unfamiliar. Mallow [1991 p. 324-325] describes his undergraduate "*Science Anxiety Clinic*". He lists students' misconceptions about reading science which the author has also identified in students of all ages. Students believe that scientific vocabulary is the same as ordinary vocabulary, that scientific texts are to be memorised, that you can read scientific writing as quickly as literature, and that all scientific reading is of the same sort and at the same level.

2.5.2 Study skills

As texts written for the purpose of instruction, study skills are an important aspect of the contexts of textbooks. Teachers integrate textbook use into a programme of classroom texts and activities. Textbooks can help students to study more effectively by providing a coherent structure to their learning. In addition, teachers may train students in the study skills they need when using textbooks. Most study techniques are effective when accompanied by,

> "*focused attention and encoding in a form and manner appropriate to the criterion task*" [Brown 1982 p. 48].

However, Brown [1982 p. 48, 1978] criticises training in "*cookbook methods*" of study skills, as "*blind rule following*". She [1982 pp. 46-50] commends "*cognitive training and awareness*" in study methods which can involve self awareness and self control, such as highlighting text, notetaking and writing outlines. As Osborn, Jones and Stein [1985 p. 11] point out, training in skills such as summarising and self questioning based on metacognitive theory improves student performance. Meyer, Brandt and Bluth [1980 pp. 97, 99], Horowitz [1985a p. 450, 1985b pp. 536-541] and Flood [1986 p. 787] suggest that instruction on the structure of expository text should improve interpretation skills and thus facilitate understanding. Cook and Mayer [1988] show that work aimed specifically at science text produces worthwhile results. Davis, Lange and Samuels [1988 pp. 211-212] point out that such instruction can be particularly beneficial to bilingual students. Applebee and Langer [1984 p.183] talk of "*instructional scaffolding*" in language tasks and Flood [1986 p. 790] proposes "*mapping*", "*questioning*" and "*rereading*" techniques for "*guided reading*". "*Elaboration*" techniques highlight links within text [Mayer 1980]. Spiegel and Barufaldi [1994 914-917] describe graphical techniques which facilitate "*text structure awareness*". Morris and Stewart-Dore [1984] explain how such strategies can be built into teaching approaches and materials. The author agrees with Brown but still values a structure for students' learning. This structure need not be as prescriptive as she makes it sound. Davies and Greene [1984] and Lunzer and Gardner [1984] advocate text related activities such as DARTs (Directed Activities Related to Text). This technique is an imaginative way to use text in the classroom. The author also concurs with Giere [1991 p. 2 and Driver et al [1996 p. 16] that training in cognitive skills in understanding and evaluating science text lead to an understanding of the nature of science which is a basic life skill. Such cognitive skills must include an appreciation of the use of and scope of scientific language.

Some textbooks, [e.g. Roberts 1971, Keeton & Gould 1986] have supplementary *study guides*. McFadden's [1986] study guide to Keeton and Gould opens with a message "*To the Student*".

> "*Retention can be increased by working with the material and explaining it to others... [...] Each chapter of the Study Guide has eight parts: A General Guide to the Reading, Key Concepts, Objectives, Key Terms, Summary, Key Diagrams, Questions, and Answers*" [McFadden 1986 prologue].

Separate study guides or study sections within a textbooks can be powerful tools to active learning when used by skilful teachers and are much more than short cuts and crammers [Tonjes 1986 p. 74]. They require students,

> "*to use the material you are studying .. [...] ... you must synthesize, analyse and interpret information*" [McFadden 1986 prologue].

2.5.3 Advance Organisers

The importance of Advance Organisers as aids to learning has been described by a number of authors. The Advance Organiser is a brief text written at a more general, inclusive and abstract level than the text itself. It provides a framework or scaffolding prior to the reading assignment and links with the reader's prior knowledge [Tonjes

1981 pp. 131, 133, Mallow 1991 p. 333]. In a review of Ausubel's theory in relation to learning in science, West and Fenshaw [1974 pp.72-75] found evidence to support the use of Advance Organisers in science text. Harrison [1980b pp. 26-27] describes how Advance Organisers in text help readers tackle a passage . For Ausubel [1968],

> "*The most important single factor influencing learning is what the learner already knows.*" [Ausubel 1968 p. vi].

This prior knowledge is activated through Advance Organisers.

Karahalios, Tonjes and Towner [1979] found a significant difference in comprehension between a group of students using an Advanced Organiser and a control group. Langer [1982] extends this idea to pre-reading assessment/instructional activities based around Anderson's [1983] ACT (Adaptive Control of Thought) model of memory and schema theory. Facts or "*declarative knowledge*" are described within a "*propositional network*". Skills or "*procedural knowledge*" are described as "*productions*". The interaction between the two represents cognition [Anderson & Bower 1973, Anderson 1976]. Prereading activities enable students to approach reading tasks with "*greater cognitive readiness*" [Langer 1982 pp. 150-153]. Flood [1986 pp. 787-790] lists seven factors for "*presenting information before reading*". These are, relating new information to prior knowledge, dealing with misconceptions, establishing purpose, making the information manageable, soliciting active responses and providing adequate feedback, linking items of information and summarising. As Perera notes [1984 p. 323] there is also evidence that readers gain help from a statement of the overall theme included near the beginning of a text. Weisberg [1970], Goldsmith [1984 p. 52], Morris & Stewart-Dore [1984 p. 53] and Tonjes [1981 p. 138] have shown that visual forms of advance organiser such as maps and graphs, are more effective than the verbal forms.

In a brief review of the literature on Advance Organisers, Tonjes [1981 pp. 133-134] reports conflicting results. Luiten et al [1979] who examined 135 studies, Kozlow [1978] and Mayer and Bromage [1980] found Advance Organisers facilitory. However, as Mayer [1983 p. 48, 1989, 1992 pp. 251-252] points out, Advance Organisers may improve the recall of conceptual information and problem solving at the expense of technical information and verbatim recollection in science prose. The author considers Advance Organisers worthwhile. They fit into a standard pattern of topic layout within a textbook. Osborn, Jones & Stein [1985 p.11-13], Roller [1986 p. 57], and Kantor, Anderson and Armbruster [1983 p. 61] agree that students find such structures as helpful as the text they contain. Advance Organisers should be particularly helpful to students who fail to read complete passages due to language difficulties. As they invoke prior knowledge, creating Advance Organisers appropriate for multicultural classrooms is a considerable challenge.

2.5.4 Headings and questions in textbooks

Winn [1987 p. 177] suggests that headings help 14-15 year olds to recall, search and retrieve information but not younger students. Wilhite [1988 p. 223] discovered that this was only significant in readers who had high levels of existing knowledge. This finding led him to suggest that the effect of headings was linked with the existence of appropriate "*schema*". Harrison [1980b p. 28] advocates the distribution of questions throughout a text. Such questions encourage "*an active interrogation of the text*" [DES 1975] and produce better learning. However, the distribution of questions throughout the text also encourages the *short bursts* strategy in reading which, as explained earlier, (see 2.3.2) fails to promote proper reading skills. Burnhill and Hartley [1975] suggest that questions should be placed before the content to be learnt, expecting to encourage "*specific learning*" of the text. They argue that,

> "*questions placed after paragraphs tend to lead to more generalised learning*" [Burnhill & Hartley 1975 p. 67].

However, Rothkopf [1970] found that questions placed after a text were more effective in maintaining learning behaviour. Listing the main points of a passage, interpretation of metaphor and drawing inferences from text are appropriate questions which encourage careful reading of text [Lunzer & Dolan 1979 p. 77]. The form of questions asked on previous occasions, i.e. "*verbatim*" or "*conceptual*", affects students' reading of science textbooks [Sagerman & Mayer 1987].

The author prefers any questions related to text to be included on separate worksheets or activity sheets [e.g. NCCT 1992-94]. This strategy enables teachers to exploit the advantages of active text interrogation without the disadvantages of short bursts reading pointed out by Carré (see 2.3.2). Teachers can withhold the questions until students have actively engaged the text, discussed it and reflected on it. There is also an opportunity to offer differentiated reading activities to individual students. Questions are most effective when asked by a live teacher, [Rothkopf & Bloom 1970 cited in Carroll 1974 p. 176]. Carroll calls this effect "*social facilitation*". The format proposed releases the teacher to talk to students individually. However, in the author's experience, the placement of questions within text is favoured by publishers and editors [e.g. Charles 1994, Walker 1994]. It is justified as "*What teachers always ask for*" and "*something which sells books*" [Charles 1994].

2.6 Interpretation and context

The key to written and graphic text is interpretation in context. The relationship between author and reader is affected by the distance between them in both time and space. Printed text suffers from a lack of opportunity of body language, a lack of instant feedback, the restriction of that relationship between participants which facilitates the correct selection of language codes and content contexts. The result is language, which in some respects is more polished and can be reviewed, but which is not tailor-made for the individual reader. Messages within the text project a schema within which the reader interprets the text. Various authors [Berkowitz 1986 p. 163, Meyer, Brandt & Bluth 1980, Taylor & Beach 1984 p. 135] describe this schema based on assumptions made by the author concerning the cultural and linguistic background of the reader. The correct interpretation and acceptance of the schema on the reader's part is fundamental to understanding. There is a host of potential problems for bilingual students concerning both cultural and linguistic understanding in interpretation of text.

As Horowitz [1985b p. 535] points out there are distinct differences between non-fiction printed texts and the printed fiction texts with which students are more familiar and which they may find easier to process. Various authors describe these differences. There is more variety in structure in non-fiction [Perera 1986 p. 57]. More information-processing is required of the reader. The material is presented in logical sequence, as compare/contrast, problem solving or cause and effect, rather than in time sequence [Littlefair 1993 p. 45, 1991 pp. 14-15, Horowitz 1985a p. 452, 1985b pp. 534-535]. Data is classified hierarchically [Rivard 1993 p. 68]. Perera [1986 p. 59] found that fiction involved fewer nouns with more pronominal repetitions than non-fiction. Fiction is high in adverbial clauses of time and nominal clauses expressing direct speech, whereas non-fiction uses relative clauses and adverbial clauses other than of time. In other words, fiction uses the kind of subordinate clauses which students use anyway, whereas in non-fiction they meet a considerable density of unfamiliar clause types.

Eagleton [1983] suggests that the appeal of a novel or literary work is that the narrative can be interpreted in a variety of ways and at several levels of meaning [e.g. Lodge 1994 p. 21]. Such reading in the light of one's own experience is what provides the entertainment. The intellectual challenge within literary text, folk tales and legends, lies in the reader's creation of the text in partnership with the author and possibly other interpreters such as actors, directors, designers, translators and illustrators. The reader draws on their own personal experiences to interpret the text. Even if the reader misinterprets the author's intentions it is still possible to enjoy reading the text and thus fulfil its purpose. This is what Davies and Greene [1984 p. 42] call "*receptive reading*". As Magee [1985 p. 36] explains, a scientific paper is an entirely different kind of text. It is written in precise terms and there is just one meaning in the text, as intended by the author. Scientific language ensures that the writer and reader play the game of comprehension to a rigid set of rules which are familiar to a distinct audience. This practice is exclusive. The intellectual challenge comes after reading the paper when it is discussed in the light one's experience. This calls for a "*reflective reading*" [Davies & Greene 1984 p. 42] of the text.

Just as the reader of literature uses part of the author's meaning when reconstructing a text, no reading of a scientific paper is totally detached, the reader uses their own, or "*members' resources*" [Fairclough 1989 p. 11], in interpreting the text. Each form uses linguistic devices to keep these deviations from the model down to a minimum. Literature uses the first person narrative and direct speech to involve the reader in the text, inviting them to reconstruct it. The text is there to be enjoyed rather than challenged. Science writing uses the third person passive voice and indirect speech to distance the reader from the action. As Sutton [1996 pp. 11-12] points out, this form evolved during the 17th century as an aid to scientific discussion. Literature uses poetic metaphor and descriptive language. Science uses a technical, precise, register. Some technical words were coined metaphorically. There is no novel metaphor.

A particular dialect or form of common parlance may be part of the part of the literature experience [e.g. Kelman 1994, Grapevine1994], whereas science writing which is discussed in Chapter 3 uses the codified, standardised (see 3.2), restricted precision of the science register (see 3.4). Davies and Greene [1984 p. 41] suggest that whereas students regularly encounter the conventions of literature in their everyday lives, science writing may be far less familiar. This makes communicating the technical language of science very difficult. American computer analysis reported by Perera [1982b p. 130] showed that the average sentence length for "*general fiction*" was fourteen words whilst that for "*scientific and learned writings*" was twenty four words.

Stories offer a whole-text structure which "*could ultimately have enormous implications for text book writing*" [Harrison 1980b p. 26, Voss & Bisanz 1985]. For it to have survived within an oral tradition,

> "*the structure of a folk story must be one which has been influenced by what people can remember*" [Mandler & Johnson 1977 p. 113].

These structures should facilitate recall. Several authors [e.g. Mandler & Johnson 1977 pp. 118, 133, Perera 1984 pp. 323-325] describe the "*ideal schemata*", episodes are linked causally rather than temporally, each protagonist is introduced as they appear. The author agrees that the genre has something to offer in terms of accessibility and students' ability to recall information. In particular, it could be used in descriptive science text where there is less pressure to use scientific grammar (see Chapter 3: 3.5-3.5.6), for example *The Rose Detective* [Blum 1982], a school science text which introduces all the relevant vocabulary through a story. Structuralist literary criticism can reveal the "*intriguing powerful complexity*" [Culler 1986 p. 87] of a novel previously viewed as a simple narrative, in terms of narrative, enigmas, culture and relationships. A similar analysis of a textbook, elucidates relevance and purpose in addition to factual content. The author applies Barthes' view, of text as a "*space in which to experiment*" and the reader as "*producer*" rather than "*consumer*" [Culler 1986 pp. 16-17, Eagleton 1983 p. 137], to science textbooks The author views a textbook as a space which readers use to try out scientific ideas and theories rather than as an opportunity to assimilate facts [see also Flood 1986 p. 784].

2.6.1 Language across the curriculum

Issues concerning language across the curriculum have been debated for many years. The Bullock Report [DES 1975] stressed the need for all subject teachers to consider themselves teachers of English. The committee of inquiry who compiled the report wrote that,

> "*the role of language throughout the curriculum should be an important consideration in secondary schools*" [DES 1975 pp. 146, 188-193].

Many schools took up the challenge presented in the report and produced language across the curriculum policies [DES 1975 pp. 192-193, 237].

More recent Government policy statements on the curriculum have included Reading as Attainment Target 2 in the National Curriculum for English [DESWO 1990 pp. 7-11 and 31-34]. This document reflects a literary approach to text interpretation. There is a clear progression in the students' expected "*personal response*" to, and "*constructive criticism of*", all forms of text [DESWO 1990 pp. 8-11]. In the author's experience, this form of textual interpretation taught in English lessons is often rejected in science classrooms. This lack of agreement between subjects is a wasted opportunity. Collaboration between Science and English departments can be very successful [e.g. HCC 1988 pp. 25-31, Ross & Jarosz 1978]. There is potential for cross curricular work, of benefit to all, which would present a coherent language policy to the students as recommended in the Bullock Report [DES 1975]. Such a collaboration could access common objectives such as finding, selecting and using information effectively, identifying its structure, key points and new words [DESWO 1990 20 p. 32] and recognising the difference between fact and opinion [DESWO 1990 p. 9]. It would address problems associated with the science register and the impersonal nature of scientific discourse discussed by Flower [1980 pp. 197-198]. Students might learn that different forms of English are required in different situations. A school language policy based on these principles should be written as a statement of students' entitlement [e.g. Sutton 1994 p. 16].

2.6.2 The reader's position

The writer of any text makes various assumptions about the reader. Personal letters may make little sense to the outsider due to the personal assumptions and meanings agreed between the writer and the recipient. Public writings such as textbooks are aimed at a wider audience. They also rely on a set of assumptions which the author has made about the reader. Kress [1985a] sums these assumptions up as the *reader's position*. The reader's position includes assumptions about matters such as, culture, subject knowledge, meanings of words, phraseology and relevance of context. Another aspect of the reader's position which is of particular interest to Kress is the social and power relationship between the author and reader. In writing about the readers' position of a text, Kress [1985a] comments that,

> "*Any reader who is not part of the social occasion of which this text is a part and a result, and of which this genre is an encoding, will not find himself positioned as a reader*" [Kress 1985a p. 43].

Understanding the reading position is important to an understanding of the text, it provides the reference point against which the reader judges and interprets the text.

Kress also distinguishes between "*resistant*" and "*passive*" readers, who "*reconstruct*" the text to a greater or lesser extent in response to "*the reading position encoded in text*" [Kress 1985a p. 42, Tierney & Mosenthal 1982 pp. 56-57]. The reading position encoded in literary text invites the reader to be creatively resistant whereas that found in scientific text insists that the reader is passive (see 2.6). A reading position should be clear, consistent throughout, indicate changes clearly and be appropriate for all students [Adams & Bruce 1982 pp. 3-9]. Readers have,

> "*different discursive histories, different present social positions to those of the writer, and the writer's coded reading position*". "*Every reading requires some reconstitution of the text*" [Kress 1985a p. 42].

A reader who misinterprets the reading position will,

> "*reconstruct the text from the point of the contrasting discourse*" [Kress 1985a p. 43].

The "*best*" reader is "*the critical resistant reader*" [Kress 1985a p. 40], a resistant reader who, although they accurately interpret the reading position, assimilates the text through active reconstruction in the light of their own experience. For Sutton [1992, 1993a, 1994] "*authorship*" and "*worlds*", where readers perceive the idea of, a real person, reporting the activities of real people, using particular language within a particular milieu, should aid this process.

Kress [1985a] argues that,

> "*The text itself imposes limitations on its reading and reconstruction*" [Kress 1985a p. 42].

This is revealed in science textbooks through genre and register. The *schema* which a reader brings to a text provide a structure into which new knowledge will fit, a means to evaluate the text, the basis for inferences, a guide to types of information and facilities for editing and generating hypotheses. The author contends that scientific language proficiency is an important component of the schemas which students bring to science textbooks.

Osborn, Jones and Stein [1985 p. 10-11] explain that the reading position has distinct implications for any student culturally or linguistically distanced from the writer or their intentions. When a teacher asks students to read a textbook neither their intended meaning, nor that of the author, is automatically transferred into the mind of the student. Bell and Freyberg [1985 p. 33] point out that individuals construct meanings from various stimuli present in the learning environment. A textbook tells a story [Turvey 1993] and in so doing it appeals to familiar context and selected prior knowledge. On the other hand, it uses the precise language of the scientific register to convey scientific knowledge. The reader's position changes from their own interpretation of the text in the light of their own culture and experience, to their assimilation of non-negotiable precise scientific knowledge.

One could also describe a *viewer's position* for illustrations and layout. The viewer uses this information to *fill in* the missing information such as pigmentation and illumination. As Constable, Campbell and Brown [1988 p. 91] point out, in reading text, "*the viewer makes such a large contribution to such representations the need for familiarity is considerable.*" [Constable, Campbell & Brown 1988 p. 91].

The reader's and viewer's positions are aspects of the *genre* of text, the lens through which the discourse is viewed. Kress [1985b pp. 142-143] explains that they reflect social, political and cultural structures and practices. The readers' position is not consistent in a science textbook, there are switches from the familiar, literary form, to the unfamiliar, scientific form, linked to similar switches in language. An understanding of the reader's/viewers' position throughout a text is necessary for *whole-text* comprehension.

2.6.3 The role of images in creating context

The images found in a textbook, the photographs, line drawings, scientific diagrams and cartoons in some instances, contribute to the reader's position. They help the reader to create a subject and cultural context. Unfortunately, images are more explicit than written text and consequently they may emphasise the gap between the reader's experience and the reader's position. For instance, a reader can make a written or verbal description of a baby being born their own by imagining their own family and circumstances, race and culture. When one is directed through an image, where the context is explicit, there is less room for negotiation. There may be a dissonance between the picture developing in the mind of the reader of accompanying written text and the image. Figures may thus play an important role in difficulties associated with accessibility. Photographs are more explicit than drawings. The explicitness of images varies from photographs through scientific diagrams to line drawings. In the author's opinion, cartoons are very stylised images dealing in cultural stereotypes. As such they can be very explicit in a very unrealistic way. This may make some cartoons unsuitable for multicultural audiences.

Graddol's [1992] analysis of Indian magazine advertisements supports the idea of a cultural element in the grammar of graphical representation. The "*direction of gaze*" [Kress & van Leeuwen 1990 pp. 27-28], which is involved in the interpersonal distance between text and reader has direct cultural meanings for Graddol. Interpretation of page layout differs between Eastern and Western cultures [Kress 1996]. Pettersson [1982 pp. 43-44], points out that the "*recto-linear*" form of post industrial western society is reflected in western published material. Chaplin [1971] in Uganda, and Winter [1963] and Hudson [1967] in South Africa found that Africans totally misunderstood the traditional western graphic symbolism of the sun with lines radiating from it. South African workers had difficulty associating two drawings intended to represent *before* and *after* scenes. Other studies [Garland 1982, Goldsmith 1984 pp. 149-150, 359-362, Fussell & Haaland 1978] found drawings which violated cultural conventions. Such cultural differences in understanding symbolism may be important in the understanding of highly symbolic representations such as scientific drawings.

Viewers who are members of a minority culture are likely to sustain their self image and create images within ethnic and family role models and situations. The schema within which they interpret images is likely to have a strong cultural component. There may be dissonance between schema and image, depending on the explicitness of the image concerned. This is a form of interpretation which is liable to persist. Viewers from minority cultures are more likely to assimilate the dominant cultural conventions in graphical grammar and page layout through contacts with the dominant culture's media and society in multicultural Britain. It follows that problems associated with cultural contexts may be more important than difficulties associated with symbolic representation.

2.6.4 Student interest through relevant context

The popularity of secondary school science courses such as Nuffield Co-ordinated Sciences [NCCT 1998a-g] and Salters' Science [The Salters Science Project 1990-92] is testament to moves away from *pure* science courses towards a more *context driven* approach. These courses claim to motivate students through their perception of the *relevance* of the science. However, as Layton [1991] points out, whether professional science drives, or is driven by, contexts and applications is an open question. Teachers employ various sorts of context in the quest for relevance. An example of a *local context* might be the description of a chemical process in a nearby factory to illustrate chemical reactions. A *global context* might involve a discussion of Third World energy needs in a topic on alternative sources of energy. Other examples of the use of contexts are reference to activities in a *classroom context*, explanation through *analogy*, the *application* of scientific ideas, and the exploration of *issues*. Contexts and analogies are bound within the dominant culture or are discussed from that viewpoint. They are specific. Applications and issues are less specific and less culturally bound. They are generalisations open to various unspecified examples and points of view. True science deals in generalisations as explained in Chapter 3 (see 3.4.3). The author believes that debating issues and applications is a more scientific activity than studying specific examples. Referral to classroom activities serves to co-ordinate learning experiences and explains the relevance of them.

Some science textbooks [see NCCT 1988a pp. 3-4, The Salters Science Project 1990-92]] appeal to readers through selected *interesting* or *familiar* contexts and analogies. Tierney & Mosenthal [1980, p. 83], Wong [1993 p. 368] and Turvey [1993] discuss the need for such *context creation* which implies a reader who assimilates the argument without referring to prior knowledge. Although the selectively contextualised argument in the active voice, replaces the third person detached argument in the passive voice, the author's point of view is still dominant and prescriptive. Such contrived "*contexts of culture*" [Halliday & Hasan 1989 pp. 6-7] may have important multicultural implications if they assume an *assimilationist* or *integrationist* stance towards bilingual students as described in Chapter 1 (see 1.2.1). Some teachers [MEG 1995, Inagaki 1990] argue that biology has *built in contextualisation*.

The issue of appropriate contexts was raised in the debate about a National Curriculum,

> "*It is well established that the choice of context has a strong influence on pupil's performance, and this applies particularly to ethnic minority pupils*" [NCC 1989 p. A10, see also DESWO 1988 p. 92].

Materials should,

> "*reflect the pupil's own first hand experience of life, including cultural, linguistic and social experiences, and reflect the multi-ethnic, multicultural nature of British and world society*" [Runneymede Trust 1993 p. 46]. "*Children learn best if the teaching they receive is related to, and seeks to draw on, what they already know*" [DES 1989a cited in Runneymede Trust 1993 p. 6].

A prescribed context may be inappropriate to individual students, on gender, culture or interest grounds, requiring teachers to teach and *sell* the context in addition to the science. Everyday contexts may invoke everyday explanations instead of scientific generalisations [Hennessy 1993 p. 9, Driver, Guesne & Tiberghien 1985 p. 196] and may complicate the application of logical reasoning [Solomon 1987 p. 78].

The author agrees with Wong [1993] that students should be invited to create and share contexts for concepts, an objective best achieved through issues. This view links with the concepts of "*interpersonal negotiation*" and "*harmonisation of world-views*" put forward in Baker and Taylor's [1995 pp. 701-702] recent review of research into the effects of culture on learning in science in various countries. When tackling issues students share resources of culture and experience, learning to respect and value others within a pluralistic society. However, if badly handled, an issues based approach can also provide opportunities for students to express racist and other prejudiced views. The approach requires teachers to know their students well and places demands on teachers' judgement. Martin, Kass & Brouwer [1990 pp. 543-546] describe this strategy. It implies an active student centred educational philosophy involving the "*personal view*" including "*tacit knowledge*" favoured by Polyani [1958] and the "*private realm of science*" including false starts, blind alleys, the application of judgement and experience and moral and ethical decision making which are eventually transformed into the "*public science*" of textbooks. The strategy is intended to be "*girl friendly*" and "*multicultural*" (see Chapter 1: 1.2.1 and 2.3.3). The philosopher Pitt [1990] argues in favour of this more historical, cultural and sociological, less positivistic, approach to science education. In comparison, pre-selected contexts imply a *teacher-centred*, passive, didactic, approach already packaged as public science. Pre-selected contexts are part of an experience which Pitt [1990 p. 8] describes as "*science training*" rather than "*science education*". In the Wittgensteinian terms discussed by Garrison and Bentley [1990 pp. 29-30] an issues-based approach links with "*a world picture*", "*the foundation of all predicative judgement*", whereas preselected contexts link with "*a matter-of-course foundation for research*" [Wittgenstein 1969 sections 93-95, 162 & 167].

The issues based approach to science education is a response to changing attitudes to science and scientific experts in the 1980s and 1990s. The post war passive acceptance and unquestioned value of science linked with technological progress and economic advance, dating back to the Industrial Revolution, has given way to a healthy scepticism characterised by the growth of protest pressure groups and reduced uptake on science courses. The issues based approach acknowledges that Wittgenstein's 1950 observations,

"*I take as true what is found in text-books,*" and

"*The schoolboy believes his teachers and textbooks*" [Wittgenstein 1969 162, 263]

may not apply to many school science students in the 1990s.

2.7 Summary

Following on from the discussion about the relationship between text and context towards the end of the last chapter, this chapter focused on context, with particular reference to school science textbooks and their use in science classrooms. The chapter provided a pragmatic foundation of context related issues such as spoken English, the role of images, reading, text interpretation and its use for teaching and learning. The chapter emphasised the importance of the relationship between prior knowledge, context and culture with particular reference to bilingual students.

Wittgenstein [1969] discusses the assumptions based on experience, culture and what they have been told from an early age, which people have to make in order to make any sense of the world. Part of the difficulty with science is the way it challenges many of these assumptions. Many teachers expect students to assume that textbooks and teachers are always right. These contradictions and clashes in beliefs and world view, which cause difficulties in understanding school science textbooks, were addressed towards the end of the chapter. Wittgenstein's assumptions fit well with the idea of *text schema* which organise one's thinking when reading and which pervaded the chapter as an underlying theme. The next chapter deals with scientific language which is an important aspect of the school science textbook schema as both a means of expression of scientific ideas and as a tool which enables scientific thought to occur. Scientific language contributes to the text of school science textbooks which operate within the context discussed in this chapter. The influences on school science textbooks arising from the social purpose described in this chapter, i.e. instruction, are developed further in Chapter 3 into the school science textbook genre.

Chapter 3: The language of schools, science and school science textbooks

3.1 Introduction

The science classroom is a rich linguistic environment where students and their teachers make use of a range of written and spoken texts which interact with one another. Accounting for ethnic and cultural diversity in terms of the "*language of science*" and the "*language of instruction*" takes place at the "*school and teacher level*" [NCC 1989 p. A10]. School science textbooks are amongst the resources which should make this possible. Teasing out the linguistic and graphic strands which contribute to these texts throws light on the major influences on them, their purpose and origin. This chapter examines issues concerning the language of the texts discussed in the last chapter and provides an introduction for the detailed discussion of an exemplar textbook in Chapters 5 and 6. The chapter covers the linguistic aspects of the "*context of situation*" and "*context of culture*" [Halliday & Hasan 1989 pp. 6-7]. A model of scientific language or "*the science register*" is put forward consisting of Standard English, scientific lexis and scientific grammar. The science textbook genre, writing style and visual and graphical aspects of register are also considered.

3.2 Registers, dialects and Standard English

Halliday [1978 p. 35] makes a distinction between "*register*" and "*dialect*". Whereas registers are variations in language "*according to use*", dialects are variations in language "*according to the user*". Accents are different forms of pronunciation, often associated with geographical areas. Mercer and Maybin [1981 pp. 78-84] describe dialects as different forms of a language often associated with geographical areas, and hence accents, but which may also be associated with social class and status. Dialects have their own words and sentence constructions [e.g. Daiches 1980].

Mercer & Maybin [1981 pp. 83-84] describe Standard English as a prestigious dialect associated with power, influence and the middle and upper classes. Leith [1983b pp. 45-49, see also Cameron 1995 pp. 41-46, Crowley 1989] traces the standardisation of English, through the general acceptance of the East Midland dialect as a written standard to its adoption by Caxton and in official documents in the fifteen century and its acceptance in literature in the sixteenth century. It was adopted as a spoken form in the late sixteenth century, as "*most courtly speech*". Its status derives from historical accident rather than any inherent linguistic quality [Leith 1983a, Edwards 1984 p. 79]. Other dialects,

> "*became patois, unwritten vehicles for informal everyday conversation*" [Leith 1983b p. 50].

Finally, Standard English was "*codified*" in books such as Dr Johnson's Dictionary and the work of grammarians in the eighteenth century [Leith 1983b pp. 54-58]. Standard English is often confused with Received Pronunciation or *BBC English*, a prestigious, codified, form of pronunciation which is just one of many alternative accents which could be used [Leith 1983b pp. 58-61, Blackburne 1993 p.3]. Using this "*socially dominant dialect*" does not imply "*a superior grasp*" of "English" [Wood 1988 p. 92, Honey 1983b p. 164].

As Halliday [1978 p. 35, Halliday & Hasan 1989 pp. 41-43] points out, whereas registers are "*occupational varieties*" of language, dialects are "*subcultural varieties*" of language. A register will be expressed in a particular dialect of English. Speakers may learn several dialects, either in succession, or in coordination, switching between them according to the context of situation. The dialect becomes an aspect of the register [Halliday 1978 p. 34]. Scientists will select dialects depending on content, context and audience [e.g. Fenyman 1985]. Leith [1983b pp. 50-51] explains that scientific discourse tends to be conducted in the science register and Standard English. Standard English not only has status, it also offers precision and universality because it is codified.

As Honey [1983b p. 175] points out, most school textbooks are written in Standard English. He [1983a p. 33-34] criticises "*Dialect-fair instruction*" [Berdan 1981, Edwards 1983 p. 197], where textbooks were rewritten into many varieties of Non-Standard English, on the grounds that such exercises corrupt the language. In the case of science text, where the register and Standard English are so closely linked, rewriting would seem to create more problems than it solves. Non-Standard English is uncodified. It lacks precision and universality. If books written in Standard English were introduced sympathetically to students who only know Non-Standard English, the students would be encouraged to broaden their *linguistic repertoires* (the range of forms of language at their disposal). Much of the discourse between students and teachers in schools is conducted in Standard English, at least on the teacher's part [see DES 1980 p. 99, Mercer & Maybin 1981 p. 81]. Unfortunately, as Halliday [1978 p. 104] observes, students who use non-standard dialect may be penalized by the teacher and expected to *"adjust"* rather than given help. Research [SCAA 1995 pp. 10-11] shows that fewer boys than girls and fewer 15 year olds than 11 year olds use spoken Standard English exclusively. The research also indicated the conscious selection of non-standard forms by some students.

A decline in students' understanding of, and use of, Standard English is often cited [Honey 1983a, Open University 1988 p. 55/56] as evidence for *"declining educational standards"*. The Kingman Report [DES 1988, Open University 1988 p. 58], was a Government initiated attempt to produce a model of the English language to be used and taught in teacher training and schools. The model put forward is a form of Standard English. Prescriptive statements on Standard English, in the 1995 National Curriculum orders for English [DFEWO 1993, 1995b pp. 18, 22, 24, 26-27] are a contentious issue [see Cameron 1995 pp. 91-92, 101-104, Blackburne 1993]. The political right place importance on Standard English because it is the language of The State, The Law and Commerce. It is seen as a prerequisite for social advancement [see Blackburne 1993, Passmore 1994b, Hofkins 1994b]. Right wing thinkers value the discipline imposed on students by rigid language rules. Honey suggests [1983a, 1983b] that the promotion of Standard English is an important function of teachers who should insist on its proper use and should correct errors. Cameron [1995 pp. 79-115] chronicles the *"moral panic"* of this period in the history of the English curriculum as an example of the imposition of *"verbal hygiene"*. She argues [1995 p. 109] that one motive behind this *"grammar crusade"* was to protect the English language from the *"multilingualism"* promoted by teaching community languages to ethnic minority students. The author agrees with Edwards who denounces attitudes such as Honey's as, *"both impractical and counterproductive"* [Edwards 1984 p. 91]. Edwards argues that by accepting other language varieties in the classroom the teacher can develop an awareness of forms which are appropriate in particular situations, thus extending students' linguistic repertoires.

3.2.1 Common parlance

Common parlance describes the way each student speaks or writes in science lessons when they are not using the science register. The term is not intended to be pejorative. The common parlance used by individuals may vary considerably within a single classroom. Students differ physically, socially, culturally and intellectually. However, generally students can still understand one another and agreed meanings are brokered through social interaction. Classroom discourse is conducted through a mixture of *language codes* (languages, dialects and registers) rather than through a hybrid or compound form. However, switches between codes may be frequent and rapid. Common parlance does not qualify as a register in Halliday's terms described above in section 3.2. It is not specific to a particular purpose. As Richards [1978 p. 91] points out, teachers may sometimes use common parlance when explaining analogies (see for example ,Appendix B, Transcript 10111 lines 100-122), a code switching strategy which she calls "*role borrowing*". Lemke [1989 p. 33] commends this approach as good practice. However, common parlance could not replace Standard English in science classrooms and textbooks because it is not standardised or codified. It is not precise enough for scientific discourse and it would be impossible to produce one such textbook for national use. Common parlance has the status of some local languages in overseas schools. However, as a spoken form in local usage, it is effective.

Most students are more familiar with their common parlance than they are with Standard English. Only 23% of fifteen year olds [SCAA 1995 p. 6] use Standard English as their common parlance. As Lemke [1989 p. 34] points out, students who have a good grasp of Standard English are at an advantage in the educational setting. It is difficult to predict bilingual competence in Standard English. Standard English is the form used in EFL and ESOL courses, whereas students who learnt their language on the streets are more likely to be fluent in common parlance. As the selection of dialect is generally a social phenomenon one might expect to find less variation within schools than between schools.

3.2.2 Linguistic repertoire

Lemke [1985a, 1985b] suggests that science classroom discourse uses a "*hybrid register*". A variety of English which ,

> "*mixes the language of science textbooks and formal lectures on science with what we might call Common Parlance*" [Lemke 1985a pp. 15-16].

The author prefers not to describe common parlance as a separate register which is too specific a term to describe such an umbrella concept. All texts are mixtures of language *codes* (this is an inclusive term covering all language variants including registers, dialects and languages). Participants select codes to suit situations and switch codes as appropriate. Code selection and switching are an important part of the meaning of a text. These choices are limited by the "*linguistic repertoires*" [Open University 1988 p. 16] available to the individuals concerned. The linguistic repertoires of multi-lingual students vary depending on the extent of their multilingualism and the codes which they command within their languages. A science classroom is the meeting place of registers and discourses involved in science, education, and the act of teaching, with everyday languages, dialects and Standard English (see Transcript 10111, Appendix B). A consequence of this view of language and linguistic repertoire is the likelihood of frequent *code switches* between language forms. Code switches involving the science register may be subtle and may employ unfamiliar language forms. The student's failure to interpret a code switch in a text may render a whole passage unintelligible to them [NCC 1989 p. A10]. Such problems are particularly likely to arise when an intended *familiar context* is totally alien to students [NCC 1989 p. A10]. Scientists and teachers may use code switching to manipulate an audience or to confer status or power on a speaker or proposition. However, the author recalls interviewing scientists who avoided scientific language in order to make their discourse more accessible (Interviews with Helen Sharman and Jocelyn Bell [NCCT 1992-94]. see also "*role borrowing*" 3.2.1).

3.2.3 The language of secondary education

Barnes [1971 pp. 53-62] coined the term the "*language of secondary education*" for the sort of language commonly used by teachers in classrooms. He did not recognise individual subject registers, calling his language of secondary education a "*register*" and linking it with Berstein's [1971] "*elaborated code*". In the author's opinion, the language of secondary education is derived from common features of several subject registers. He rejects it, like Lemke's hybrid, as a register. Barnes [1971 p. 53] describes the language of secondary education both as a "*spoken register*" and "*the language of textbooks*". Teachers' talk is more like written English than most spoken English. In many ways it is well *rehearsed* and lacks the flaws caused by spontaneity (see Appendix B Transcript 10111 lines 058-143). In the author's opinion, the language used by teachers and textbooks varies between subjects due to the influence of subject registers. Any similarities between the language used in different subjects, which gives rise to the *language of secondary education* is due to the fact that subject registers are complementary with Standard English. This fits with the links which Barnes [1971 p. 53] makes between his register "*social life need*" and "*public language*" rather than linking it with the language of subject-based professionals. Barnes [1990 pp. 52-53] later shifted, referring to the language of secondary education as "*a cluster of styles rather than a register*" emphasising links with the impersonal "*consultative style*" [Joos 1962] of public debate, committee meetings and academia.

3.2.4 An education register

The following section of the Nuffield Co-ordinated Sciences Teachers' Guide refers to an extract from the biology textbook.

> "*The kidney is considered in this section as a filtration unit. Details of the structure and function of the nephrons are not required. This section can be completed with Worksheet B12C, which emphasises that the amount of water inside the body needs to be regulated if damage to cells is to be avoided. The kidney plays a major role in the maintenance of a constant water level in the body. Worksheet B12D examines the functioning of the kidneys more fully.*"
> [NCCT 1992a p. 129]

This text is aimed at teachers and concerns implementing a science curriculum. It features its own specific jargon and turns of phrase connected with a profession. In Halliday's [1978 p. 35] terms, the language of this educational discourse is a register in its own right.

> "*This section can be completed with worksheet B12C*"

Part of the extract is written in the education register including scientific lexis.

> "*Details of the* ***structure and function of nephrons*** *are not required*"

The switch from education register, to scientific lexis and back again is clear because they have such different content and purpose. The difference between what to do (education register) and the material being acted upon (scientific lexis). With the implementation and explanation of science, the language switches entirely to the science register.

> "*the amount of water inside the body needs to be regulated if damage to cells is to be avoided. The kidney plays a major role in the maintenance of a constant water level in the body*".

These extracts show that the education register, like the science register, is clearly derived from Standard English.

3.2.5 Educational writings aimed at a wider audience

The National Curriculum for Science Key Stage Four (Double Science) [DESWO 1991 pp. 23-31] was written for parents, teachers and the general public. It states the curriculum without advising on its implementation. The document does not elaborate or explain the science content beyond giving examples of suitable activities. Consequently, it does not use the education register at all and it only uses the science register in descriptions of curriculum content. It is set out in three columns, "*programme of study*", "*statements of attainment*" and "*examples*". The statements of attainment and examples are divided into "*levels of attainment*". The complexity of the science register used increases from the programme of study to statements of attainment to examples. The programmes of study and statements of attainment are basically *lists of bits of science* whereas the examples describe actual activities. The complexity of the science register used in the statements and examples increases as one moves up the levels of attainment. This is evidence for the relationship between the mastery of the language of science and mastery of the subject itself.

The education register does not impinge much on the students in schools, it is confined to discussion between professionals. Documents like the National Curriculum do reach students and their parents, are publicized in the National Press and are freely available. Extracts appear in school documents sent home to parents. Similar language appears on school reports and profiles.

3.2.6 A language of implementation: a classroom context

A group of teachers in Milton Keynes tried to use the statements of attainment with students for plotting progress, target setting, assessment procedures and Records of Achievement. This was unsuccessful across the ability range because most students found them inaccessible. The teachers [Gray 1993, MKCC 1990 & 1992] then undertook to produce *student-friendly* versions of the statements of attainment. The student-friendly statements retain features of the science register. Simplification of the language of the statements of attainment was less successful in improving accessibility than relating the statements to classroom activities. Student-friendly statements only work,

> "*when they are thought out and applied within the context of a particular scheme of science work and specific science activities*" [Gray interviewed in 1993].

In Halliday's [Halliday & Hasan 1989 pp. 36-38] terms, the students are unable to infer "*the context of situation from the text*" using the original statements. This links with his concept of "*prediction*" which relies on an understanding of register. Inevitably, simpler language was less specific. The group [Gray 1993] working on the student-friendly statements found it impossible to describe the statements adequately without using the science register. The science register is a language of implementation and explanation and only has meaning when related to real activities and changes.

3.3 Scientific genres

Scientific discourse provides a means for thinking in a scientific way and for constructing scientific knowledge. Consequently, learning science involves learning how to control the discourse features which construct scientific knowledge. Marland [1980a pp. 91-92] suggests that the nature of scientific discourse expressed through scientific grammar should be a priority item on the science teacher's agenda. Kress [1985b p. 143] explains that *genre* determines the form of expression of a discourse. Discourse by itself does not constitute text. A "*mastery and implementation of the requisite genres*" is crucial to an understanding of science.

> "*Genres are intimately tied into the social, political and cultural structures and*

practices of a given society,". "Being scientific or being a scientist has as much to do with, and is defined as much by, mastery and implementation of the requisite genres as it has to do with any other practices that constitute modern science." [Kress 1985b p. 143].

For Couture [1986, Swales 1990 p. 41] whereas registers impose constraints at the linguistic level of vocabulary and syntax, genres operate at the level of discourse structure including conditions for the beginning, continuing and ending of a text. Martin [1985, Swales 1990 p. 40] points out the relationship between genre and topics covered and the social purpose of genre. Swales [1990 pp. 83-84] sets out links between genre, schema (including familiar procedures) and prior knowledge which were discussed in Chapter 2 (see 2.6.2).

3.3.1 The school science textbook genre

The social purpose of school science textbooks which was discussed in Chapter 2 (see 2.5) is as a medium of instruction. Teaching discourse messages and definitions which interrupt the flow of the scientific discourse are a characteristic feature of the genre. Topics are introduced in a particular way with an emphasis on *relevance*, *appropriate context* and *student interest* as discussed in Chapter 2 (see 2.6.3, 2.6.4). It follows that code switches which are discussed in this Chapter (see 3.2.2) are a feature of the genre. The school science textbook genre is expressed through a characteristic reader's position as explained in Chapter 2 (see 2.6.2), page layout, headings and questions, illustrations which were also discussed in Chapter 2 (see 2.4-2.5.4) and writing style. Although some linguists consider *genre* and *register* synonymous terms, this sense of *social purpose* of genre is a useful distinction which separates them within this theoretical framework [see also Littlefair 1991 pp. 83-87, Kress 1989 p. 10]. Various genres can be used with the same discourse producing different texts. For instance, scientific discourse as expressed in the genre of the scientific paper [Hutchins 1977, Gopnik 1972] produces a totally different kind of text to that found in science education in general and in textbooks. Martin [Halliday & Martin 1993 pp. 186-200] argues that the main scientific textbook genres are report writing, explanation, biography and exposition. The science textbook genre reflects the positivist tradition in scientific writing described by Bynum, Brown and Porter [1981 pp. 333-335] which may be contrary to beliefs held by students.

The Standard English of textbooks is a political, social and cultural statement. The "*assumed status*" [Kress 1985a p. 60] and authoritarian stance of textbooks, the speaker's power and distance, are features of the genre linking with teaching discourse. Teaching discourse is characteristic of the social situation of textbook use and appears in textbook writing. These aspects of the genre affect the relationship between author and reader which was discussed in Chapter 2 (see 2.6.2). There are social and cultural implications to the Eurocentric, chauvinistic way certain *science stories* are told. As discussed in Chapter 2 (see 2.6.4) the choice of contexts for the explanations of scientific principles discussed in a textbook, in fact the need for such contexts to be predetermined at all, is a social, political and cultural statement which contributes to textbook accessibility. As discussed in Chapters 2 and 5 (see 2.6.3, 5.4-5.4.2), the choice of figures affects context and reader's position, it too has social and cultural implications. There is even a cultural, social and political component to the coinage and usage of scientific words. Sex bias and the lack of *girl-friendly* text (see Chapter 2: 2.3.3 and this chapter, 3.4.2) also affects accessibility in science textbooks. Most school science textbooks lack good role models for girls and ethnic minority students. Various authors [Davies 1986 p. 101, Zimet & Hoffman 1980, Hicks 1980, Gill 1982] describe how textbooks may transmit racial, sexist and political and economic bias.

3.3.2 Teaching discourse

Teaching discourse is the language of classroom organisation and instruction (e.g. Appendix B Transcript 10111 lines 001-025). It organises group structure, controls the noise level, and implements discipline. Teachers are faced with large groups of students,

> "*children they do not know outside that context, children who are required to attend by law or some other irresistible authority, in whose name the teacher may act to coerce attendance and compliance.*" [Edwards & Mercer 1987 p. 93].

As Edwards and Furlong [1978 pp. 10-32] point out the teacher has to employ various linguistic strategies to control and manage this situation. One feature of this *teaching discourse* is the I-R-F exchange structure [Stubbs 1983 pp. 28-30, Open University 1987 pp. 4-9],

> "*an initiation by a teacher, which elicits a response from a pupil, followed by an evaluative comment or feedback from the teacher*" [Edwards & Mercer 1987 p. 9].

Such exchanges are not scientific discourse although they may use scientific lexis as the material dealt with. They organise activities which will teach some science and may lead to scientific discourse. One object of science teaching should be to effect this change from what Edwards and Mercer [1987 p. 97] call "*procedural knowledge*", through "*ritual knowledge*" to "*principled knowledge*". Principled scientific knowledge can only be articulated using the science register. Stubbs [1983 p. 50-57] discusses how in teaching discourse,

> "*at least one of the participants takes particularly active steps to monitor the communication system*". *Such monitoring may comprise teaching or at least a major part of it*" [Stubbs 1983 p. 50].

Stubbs [1983 p. 50-57] analysed the features of teachers' talk which have a "*metacommunicative function*". He identified eight types of strategy which teachers use, *attracting or showing attention, controlling the amount of speech, checking or confirming understanding, summarising, defining, editing, correcting and specifying topic.*

By the time they reach secondary school, students should be very aware of, and should understand the expectations of, this form of discourse. Edwards and Mercer [1987 pp. 42-61, Mercer & Edwards 1981 pp. 356-370] identified a set of "*ground rules*" for what they call "*educational discourse*" which apply even in informal settings [Edwards & Furlong 1978 pp. 81-102, 148-155]. Teaching discourse should be familiar to students as a spoken form. It may present problems when it appears in textbooks. As Edwards and Furlong [1980, p. 146] point out, the home cultural experience of some bilingual students may cause them to refuse to participate in the expected classroom discourse and to resist the teacher's expectation that they should speak or remain silent as the teacher demands. This attitude may affect their reaction to textbooks using teaching discourse.

3.3.3 Definitions

Mayer, Cook and Dyck [1984] and Loman and Mayer, [1983] showed that definitions of key terms in scientific text, pretraining in those terms, and the signalling of links and relationships between them, can enhance students' reading and problem solving strategies and mental model building. Evans [1976 p. 26] suggests the inclusion of definitions in a way which makes them easy to find and refer back to. However, if not handled properly in the classroom, this "*naming of parts*" [Barnes 1971 p. 48] can take on a life of its own which is totally divorced from the task in hand [Flower 1980 p. 195]. Peters [1982 p. 150] describes the common practice of giving students definitions as inadequate without a structural framework which enables them to fully accomplish specific tasks, Mrs S.'s successful approach in Transcript 10111 (see Appendix B). Dee-Lucas and Larkin [1986, 1988] have shown that definitions are an important part of science text for non-expert readers.

Ennis [1974 pp. 286-297] lists reported. stipulated, and programmatic definitions. He makes the point that different forms; classification, equivalent expression, synonyms, range definitions, definitions by example or non-example and operational definitions, apply to different situations. He concludes that glossaries are not flexible enough in use, compared with an active teacher who can think as they talk. The value of Ennis's work is to remind teachers of the range of language forms which should be considered as definitions when using text with students. All forms of definition involve a certain amount of "*condensation*" of meaning [Halliday & Martin 1993 p. 172] which involves difficulty in understanding for some students. However, condensation makes definitions short, manageable and memorable. Rowan [1991 pp. 370-371] points out that including more than single examples and non examples makes definitions longer but improves intelligibility. Authors must compromise making definitions intelligible but reasonably brief. Definitions are closely linked with taxonomy and classification which is an important part of scientific discourse. In language terms, definitions are at the cutting edge of theory. This leads to "*interlocking definitions*" [Halliday & Martin 1993 pp. 72-73], a problem which students often encounter within scientific discourse. Williams [1981 pp. 51-55] talks of "*lexical familiarisations*" which should be highlighted through a consistent "*typographical system*" using appropriate simple language avoiding and polysemous words. He also comments on the lack of flexibility in glossaries. However, teachers at School 1018 commented on the usefulness of glossaries with bilingual students.

Marland [1980b p. 171] discusses the difficulties linked with brackets used to qualify terms in mid-sentence. This form, which is typical of scientific writing, is the equivalent of an appositive noun phrase set off by commas (see Chapter 3: 3.5.4). Technical terms may be highlighted in bold or italics, or defined within the text [Halliday & Martin 1993 pp. 115, 148-152]. The writer's problem with such systems is deciding how many words to define as frequent definitions can interfere with the flow of reading. Figures have an important role to play in the definition of terms. They demonstrate the form of the object defined and its spatial arrangement relative to other structures. Sequential diagrams illustrate processes. Such figures may explain through illustration (photographs) or exposition (labelled technical diagrams, flowcharts and photographs).

3.3.4 Using an index or a dictionary

Students can check meanings using an index. This practice is a useful study skill which teachers should encourage. An index directs the student to the part of the book which deals with a term thoroughly. Using an index enables the student to integrate seemingly unrelated blocks of subject content and facilitates the co-ordination of the science disciplines. Some schools encourage the use of dictionaries by all students. However, dictionaries have their drawbacks. A recent survey of 4,500 secondary school students [BSA 1996] found that 1 in 6 of them had difficulties using dictionaries. Dictionaries contribute to confusion when used to dealing with polysemous words and metaphors in contexts where the rest of the sentence gives no clue to meaning. Dictionaries rarely give the nominalised form of verbs as key words. Some bilingual students rely on English/First language dictionaries (Appendix A School 1004). However, there is not always a direct equivalent of a word, as used in English, in another language.

3.3.5 Stories of discovery

Another characteristic of the science textbook genre is the celebration of *great scientists* through stories of their discoveries. Such people are typically white, middle class, European males. Some of theses stories provide a biased view of history. Sutton [1993a] argues that by giving scientific discoveries "*authorship*" we make them more accessible [see also Solomon, Duveen & Scott 1994 p. 362]. Students should be taught that science was, and is, the business of real people grappling with real problems [Sutton 1992, 1993a, 1994, Mallow 1991 pp. 335 & 337, Lemke 1989 p. 33]. However, this aim could be achieved without glorifying names from the past of the dominant culture (see the interviews, in the first person active, with practitioners from various cultures in Pathways Through Science and Science in Practice Project publications [NCCT 1992-94, NF 1994]). Arguably, Fleming was serendipitous and Jenner's and Lind's ethics were questionable. The discovery of cinchona bark, the triumphs of the great Chinese herbalists, and tribal medicines, merit equal attention. Examples of good science should be drawn from a range of cultures, celebrating the international research community.

3.3.6 Writing style

Writers have characteristic writing styles expressed through phraseology, punctuation and word selection. Some textbook authors employ the role borrowing strategy discussed earlier in this chapter (see 3.2.1) used by teachers (e.g. *Pathways Through Science* source books [NCCT 1992-94]). This style involves switches between the science register and forms of Standard English considered more familiar and accessible. Editors of books written by several authors adapt individual writing styles to produce consistency. In the author's experience, most publishers and organisations insist that writers employ a *house style*, or have material edited into a house style. Some house styles are codified as manuals [e.g. Nwogu 1991 pp. 111-112] ensuring consistency across series of publications. Cameron [1995 pp. 35-38] discusses house style and editing in some detail. She explains that, in addition to using a house style manual, editors may refer to the "*editor's bible*", *The Oxford Dictionary for Editors and Writers,* in order to ensure accuracy and consistency. Editors of science textbooks will also impose consistency in the units used and abbreviations. Editors whom Cameron interviewed [1995 p. 7], explained that "*it is was their job to care about the minutiae*".

3.4 The science register

Scientific discourse is conducted in the "*science register*". Halliday [1978 p. 195] defines a "register" as "*a set of meanings that is appropriate to a particular function*" and describes registers as associated with the speaker's role in particular situations. A speaker may use one of several registers at their command, depending on the circumstances. Halliday [1978] explains that,

> "*The notion of register is thus a form of prediction: given that we know the situation, the social context of language use, we can predict a great deal about the language that will occur*" [Halliday 1978 p. 32].

As a form of prediction, proficiency with the science register contributes to the schema which a reader brings to the text both as a frame of reference and as a means of expression. As such it contributes to the reader's position discussed in Chapter 2 (see 2.6.2).

The science register consists of "*lexical resources*" and "*grammatical resources*" [Halliday & Martin 1993 p. 7-8] and is based on *Standard English*. Scientific lexis includes novel vocabulary, alternative meanings for old words, particular turns of phrase and forms of expression. Scientific lexis, discussed in this chapter (see 3.6-3.6.5), expresses the precision and classification in scientific discourse. Scientific grammar includes a particular style of address to, and requires a particular style of interpretation on the part of, the reader/listener. Scientific grammar, also discussed in this chapter 3 (see 3.5-3.5.6), may be unfamiliar because it uses unfamiliar forms of common verbs such as modals, passives and nominalisations. Scientific grammar expresses the philosophy, history and nature of the scientific enterprise. Standard English provides a rule governed, codified milieu within which the other aspects of the science register can find expression.

3.4.1 Scientific illustration as science register

A superficial glance through a book, looking briefly at the illustrations, enables one to predict whether it is a *science book*. One recognises *scientific illustration* which has a characteristic *register* in addition to the,

> "*attitude of the detached observer, the philosopher, the pure scientist*" by "*transforming the events of reality into objects of contemplation*" [Arnheim 1974 p. 183]

promoted by all images in text. Interpretation requires "*the mastery of a technique*" [Wittgenstein 1967 IIxi p. 208e]. Kress and van Leeuwen [1990 pp. 53-59] describe what amounts to a lexis and grammar of scientific illustration within their discussion of "*scientific/ technological coding orientations*". The pragmatic "*realism*" of the technical drawing described by Kress and van Leeuwen [1990 pp. 52-53] links with *scientific lexis*. The use of, decontextualisation and reduced representation, the reduction of depth and the use of shading rather than shadow discussed by Kress van Leeuwen [1990 pp. 55-57] links with the impersonal, disembedded, nature of *scientific grammar*. As Kress van Leeuwen [1990 pp. 52-53, 55-57] points out, both subject specific conventions and cultural factors affect the interpretation of scientific figures and are significant factors in the accessibility of science text . Diagram creation and interpretation skills complement scientific language competence.

3.4.2 Impersonal discourse

True to positivist ideology and philosophy, scientific discourse is impersonal and avoids personal constructions. Kress [1985a pp. 28 & 30] sees the portrayal of the scientist in the science register and textbook genre as insignificant, a *servant* of truth in the objective search for truth. Rosen [1967 pp. 100-115] discusses the impersonal language of textbooks in terms of its restrictive influence on "*the pupils' own spontaneous language*", "*subjectivity*" and "*personal involvement*" [see also Davies 1986 p. 101]. Sutton [1994 p. 13] suggests that impersonal discourse evolved in scientific writings in the seventeenth century to facilitate the discussion of experimental findings without unhelpful controversy. Scientists,

> "*could collaborate over what they did agree about*" Sutton [1994 p. 13].

If this is so, impersonal discourse is necessary to the development of scientific ideas but not to reporting them.

Watts and Bentley [1994 p. 85] compare the mechanistic, objective, causal view of science which "*is clearly dominant in the classroom*" (see Appendix B Transcript 10111 lines 083-085, 124-143), with animistic and anthropomorphic explanations of scientific phenomena, citing the work of feminist writers and women scientists (e.g. Callaway, MacKinnon, Fox Keller and Goodfield). The dominant view is "*masculine science*", the alternative "*feminine*". They argue that a move towards animistic and anthropomorphic explanation in school science might,

> "*help to "humanise" science and, in particular, assist in the participation of*

> *young women."* [Watts & Bentley 1994 p. 86].

They argue that young women favour a more *"person orientated"* view of science and urge that such person orientation should go beyond the use of everyday contexts in applying scientific concepts [see also Sjoberg & Imsen 1988 Appendix B Transcript 10111 lines 162-172]. If,

> *"animism and anthropomorphism are exactly where many students "are at""*
> [Watts & Bentley 1994 p. 84],

textbooks should reflect it. Sheldrake [1995] blames the dominant view for the poor uptake on A Level science courses although many find science interesting. He discusses the gulf between *"popular science"* and the activities of scientific professionals, lamenting that science education reflects the later. He advocates an holistic approach involving direct personal experience and wider social and cultural implications. On the other hand, White and Welford [1986, Halliday & Martin 1993 p. 199] argue that a strong personal, empathetic, response in students can lead to inaccurate observation. Narrative text, discussed in Chapter 2 (see 2.6), is unable to classify, decompose and measure, the tasks which the genres of science evolved for. As Master [1991 pp. 15, 29-32] points out, anthropomorphism causes problems for some bilingual students (e.g. Chinese and Japanese) even at the level of using active verbs with inanimate subjects.

The author thinks that a good textbook should provide a compromise between these positions. It should be accessible on the one hand and provide models of scientific writing on the other [see also Davies 1986 cited in Chapter 2: 2.5.1]. The mediation between the positions is carried out by good teaching, efficient text organisation and appropriate activities using the text as described in Chapter 2 (see 2.5-2.5.4). Selected items within textbooks could employ easily identified scientific language to be used with specific activities and language learning objectives. Textbooks should not be written and designed in an artificial hybrid register of the kind described by Lemke and discussed earlier in this chapter (see 3.2.2). This approach acknowledges that the language used in science classrooms is a mixture of language codes and that the science teacher has responsibility for developing students' linguistic repertoires within a policy of *Language across the curriculum* identified in Chapter 2 (see 2.6.1).

Kress [1985a p. 60] explains that "*impersonality*" is linked with the power of the speaker and their deliberate distancing of themselves from other participants in a dialogue. This apparent "*assumed status*" of a text is a feature which may restrict its accessibility to students unfamiliar with its conventions. However, as was pointed out earlier (see 3.2.2) not all scientists find a need to assume this status. Possibly, its use is linked to the self importance of an author/speaker. Maybe, it could be jettisoned in the name of text accessibility. Although scientific discourse is impersonal, paradoxically, *great* scientists are celebrated with the use of terms such as *Newtons*, *Faradays* and *pasteurisation*. Such jargon is typically eurocentric.

3.4.3 Hypothesis and deduction

A great deal of scientific discourse is conducted within an atmosphere of "*empiricism*", associated with philosophers from Bacon to Russell [Bynum, Brown & Porter 1981 p. 121]. Kinneavy [1971] demonstrates a remarkable similarity in scientific texts throughout this succession. However, as Winchester [1990] points out "*thought experiments*" have also played a part in key scientific discoveries. These strategies should feature within science education in the manner of presentation of ideas and in students' practical experiences.

Scientific knowledge grows by induction from an accumulating body of facts building into a hierarchy of propositions. Agreed, rule-driven classification facilitates induction. This leads to generalisations or *laws* which are judged by their instances under experimental conditions. A law refuted through experimental evidence is replaced or amended [Bynum, Brown & Porter 1981 pp. 75, 121, 203-205]. Scientific texts either generalise and explain observations of particular instances or demonstrate the *truth* of assertions or hypotheses [Hutchins 1977 pp. 32-33]. Hempel's and Goodman's induction paradoxes [Bynum, Brown & Porter 1981 pp. 204, 299, 123] concern the validity of equivalent hypotheses founded on the same evidence and the selection of features for projection to unknown instances within generalisations. Hume's objections [Magee 1985 pp. 19-21], centre on induction from a body of facts which itself consisted of theories which could be challenged. Popper [Magee 1985 p. 23] dealt with these questions through his notion that scientific theories are only "*falsifiable*" not "*verifiable*". It follows that *good* theories are capable of disproof and *absolute* theories are of little value to the forward march of science. False statements can have some truth in them and are of value [Walsh

1994]. Walsh [1993 p. 73] advocates a "*dynamic scepticism*". This view of the philosophy of science is endorsed by eminent scientists of the calibre of Medawar, Monod, Eccles and Bondi [Magee 1985 p. 9].

Two important consequences arise. First, precisely stated theories are more falsifiable and are therefore more useful to the advancement of science [Walsh 1994]. Precise theories can only be expressed through precise language, so Popper accounts for the development of the science register. Secondly, alternative theories have merit and should, therefore, be taken seriously. Alternative theories are "*alternative frameworks*" [Driver 1983 p. 3] which may be based on an individual's cultural values. Popper thus gives a philosophical underpinning to the value placed on "*student's personal resources*" and "*prior knowledge*" in Chapters 1 and 2 of this thesis (see 1.2, 2.5.3, 2.6.2). Kuhn [1970 Chapter 9, Walsh 1994] introduced the idea of "*scientific revolutions*" in place of the consistent flow of improved theories through steady induction. Here old theories are *patched up* by corollaries and special cases between cycles of total change to new theories. Induction only occurs during these revolutions.

In the author's opinion, science education preaches classical induction whilst practising the traditional conservatism of what Kuhn [1970 p 10] refers to as the "*normal science*" between revolutions. Textbook authors rewrite the history of science, including the interpretation of theories, in linear sequence leading to current theories to support classical induction and current paradigms whilst ironing out revolutions [Kuhn 1970 p. 140-141]. Textbooks,

> "*are pedagogic vehicles for the perpetuation of normal science*" [Kuhn 1970 p. 137].

There is little scope for innovation and alternative theories in science education, [e.g. the National Curriculum, DFEWO 1995a]. As Zylbersztajn [1983] points out, it is difficult to see how this classroom activity can, philosophically, mimic true science which does not have the benefit of hindsight. Barthes [1993 p. 146] draws a distinction between the "*mythology*" of "*second order language*" such as textbooks and science education and the "*language of man as producer*" such as true science which is "*not mythical*". It is debatable whether scientific classroom activity requires the precision of the science register. An inductivist argument directed at a mass audience may make detailed assumptions of the reader's prior knowledge, dealing with ideas and topics in a preordained sequence. An individualised inductivist approach elicits prior knowledge and the discourse is adjusted accordingly (See the discussion in Chapter 7: 7.5.5 about the use of "teacher narrative" with groups of special school students.). Both approaches are a long way away from true science. Some writers [e.g. Gopnik 1972 pp. 52-96, Hutchins 1977 p. 29-32] argue that descriptive scientific texts, including textbooks are "*non-scientific text*". Mallow's [1991 p. 325] "*science writing*", which includes articles in the popular press, articles in science journals and science textbooks is a more sympathetic description.

Halliday [Halliday & Martin 1993 pp. 82-84] identifies the difficulties which the "*semantic leaps*", which scientific discourse requires, cause students. Hypothesis and deduction are unfamiliar styles of reasoning, even to those school students who use these terms in the classroom. Student perception of the generalisations at the heart of scientific thought, taught through examples, may cause problems in conceptualisation. The language of explanation is complex and unfamiliar and carries little elucidation or expansion. Hypothesis and deduction account for the use of modal and passive forms in scientific discourse. Verbs like *appears,* and *seems* are speculative and are linked with hypothesising. The use of inverted commas may denote metaphor, speculation and invite hypothesising. These forms, so unfamiliar in everyday discourse are common in scientific discourse.

3.4.4 A disembedded, reductionist view of life

Contexts and issues are closely related to text interpretation and understanding. Luria [1976] and Donaldson [1978] suggest that children's thinking when embedded in the context of everyday practical activities and common sense as described earlier (see 3.2.6), can be at a higher level than when faced with similar problems disembedded from any such context [see also Open University 1987 p. 18, Carraher, Carraher & Schliemann 1985, Rogoff & Lave 1984]. Such a disembedded view is typical of scientific discourse in its purest form. This is best demonstrated with reference to scientific diagrams. As Skemp [1986 p. 90] explains, scientific diagrams leave out many of the visual properties of an object so that the scientist can abstract at a higher level but still represent the concept visually. Unnecessary, distractive, detail is edited out as described in section 3.4.1. This is a way of representing *the whole problem* and is linked with the principle of generalisation. Graphic forms such as circuit diagrams may summarise ideas better than the corresponding verbal forms. Larkin & Simon [1987 p. 98, Winn 1987 pp. 159-167] show that scientific diagrams group information by location, reducing the need to match symbolic labels and support a large number of perceptual inferences including distances between elements and sequences. They act as *organisational aids* as described in Chapter 2 (see 2.5.1).

Typically, dynamic processes are represented as labelled boxes linked by arrows. Science also uses imperfect verbal models which may select or disregard detail in a similar way. In order to understand the image, the viewer must appreciate that scientific diagrams and drawings are special representations with certain features *edited out*. The viewer must be aware of the fact that the information is presented in a condensed form. As Wittgenstein [1967 IIxi] points out, they must interpret diagrams correctly in the context of science and appreciate that the same drawing may represent various objects. For instance, as Schollum [1983] has shown, arrows may represent labels, measurements, forces, relationships and changes as well as a sequence in a process. Schollum also points out [1983, p. 56, 1981] that the diagram interpretation may reinforce the students' own, mistaken, concepts. Although the information presented is more *manageable*, it may become less *accessible*.

3.5 Scientific grammar

Issues concerned with the nature of science and scientific discourse are realised within the science register through a characteristic grammar.

> "*Essence is expressed by grammar*" which "*tells what kind of object anything is*" [Wittgenstein 1967 sections 371-373].

3.5.1 The generic use of the definite article

An example of impersonal discourse within biology is the detached way in which the body systems and organs are discussed. These systems and organs cease to be part of a living organism or person with spiritual, moral and aesthetic considerations. They become purely mechanical and functional as ***the large intestine, the blood, the intestine*** and ***the body***. This use of the definite article is not generally encountered in common parlance or fiction. It is limited to "*nationality words, adjectives as head, non-count* and *plural count nouns*"[Quirk & Greenbaum 1973 4.16-19 pp. 67-72]. In biology the generic use of the definite article extends to references to species and stages in life cycles.

3.5.2 Scientific constructions

Unfamiliar constructions such as *is said to be* are typical of the science register. As Halliday and Martin [1993 pp. 75-76] point out, these "*special expressions*" are a source of difficulty for students. Perera [1984 pp. 321-323] explains that lexical words such as *consequently* and *thus* act as "*structural signposts*" in academic texts. Students do not begin to use these words until the teenage years. *Consequently, hence, instead, moreover, similarly, that is* and *thus* are "*particularly liable to misunderstanding*" [Perera 1982b p. 131 1984 pp. 155-156, 321, Gardner 1977]. Scientists use the double negative and the word *occur* to signify spatial rather than temporal distribution.

Science uses logical connecting words or phrases such as *for the same reason, thus* and *therefore*. Perera [1986 p. 56] points out that these organising words "*carry a great deal of weight*" and that,

> "*even students aged 15 and over find such sentence connectives, which are rare in fiction, particularly difficult*" [Perera 1986 p. 56, Gardner 1977, see also Chapter 2: 2.3.4].

Perera also mentions the "*structural signposts*" typical of "*non-chronological*" texts such "*one reason.....*". Marland [1980b pp. 172-172] extends this discussion of "*signal words*" to the several unfamiliar uses of *if* in textbooks. It can mean *when, as* or *certainly*. To make their writing precise, secondary school science textbook authors tend to use a lot of qualifying words and phrases like *most, some* and *a few*. Bulman [1985] argues that such words and phrases,

> "*make the reader hesitate- they need to evaluate the strength of the qualification. This puts a barrier between the reader and the information.*" [Bulman 1985 p. 21].

Many of these constructions crop up in school science textbooks, even in purely descriptive passages which do not require scientific discourse. Elsewhere, they may be necessary in order to make the meaning precise or to express scientific discourse.

3.5.3 Syntax

Harrison [1980b p. 23] lists five types of reading difficulty related to syntax, all of which are symptomatic of the science register; passive versus active verbs, nominalisation, modal verbs, the number of clauses in a sentence and compression and substitution. Halliday [Halliday & Martin 1993 pp. 77-79] highlights the problems associated with "*syntactic ambiguity*" in science texts. Bulman [1985 pp. 22- 23] discusses students' confusion between the present continuous tense; "*The fish is breathing through its gills*"; the present simple tense; "*The fish breathes through its gills*" and the present perfect tense; "*The fish has breathed through its gills*". These tenses are used to make subtle, precise, differences in meaning in science. When nuances of meaning are combined with a lack of familiarity they can be very confusing. These grammatical forms are linked with the precision required in scientific discourse and its hypothetical deductive nature.

Fagan [1971 pp. 169-172] investigated reading problems associated with syntax in children aged 9 to 12 using 5 classes of "*transformations*". He found that, sentence difficulty depends on the number and difficulty of transformations and explained this in terms of the redundancy of the language. Deletion and embedding transformations are particularly difficult [Theberge & Braun 1977 pp. 183-189]. Flower [1980 p. 195] describes scientific language as having "*minimum redundancy*" and thus "*minimum intelligibility*". These findings link with the discussion of ellipsis and substitution by superordinates, which are important aspects of scientific discourse, in Chapter 2 (see 2.3.4) and later in this chapter (see 3.6.5).

Wang [1970] found that, although some of the structures that cause reading difficulty also tend to increase sentence length, syntactic features such as embedding were more closely correlated with comprehensibility than sentence length,

> "*it is not sentence length per se which makes sentences difficult to comprehend*" [Wang 1970 p. 403].

She concluded that comprehension was actually facilitated by long sentences when they contained co-ordinate clauses (joined by *and* or *but*) [Perera 1980 p. 156, 1982a p. 108]. Perera [1984 p. 278 see also Lunzer & Dolan 1979 p. 72] concludes that in some cases grammatically more complex sentences containing more subordinate clauses are easier to read than *simple* sentences. This conclusion [Perera 1984 pp. 283-287] links with a perceptual model which involves a preliminary analysis of text within the short term memory and findings which suggest that text is processed in clause-size chunks.

> "*The psychological limitations which make some complex sentences difficult or impossible to understand are primarily limitations of short term memory.*" [Wang 1970 p. 398].

Perera [1984 p. 288] argues that, for slow readers, grammatical relationships should become apparent within ten or eleven words to avoid overloading the short-term memory. Writers should aim to keep the numbers of subordinate clauses in sentences, which serve science by qualifying, defining, and classifying, low, whilst avoiding the sacrifice of clarity and coherence in the process. Artificially short sentences may be incomprehensible whereas some long sentences may help the reader considerably. Botel, Dawkins and Granowsky [1973 pp. 81-85] developed a "*syntactic complexity formula*". Each sentence is scored accumulatively and the scores are averaged for the passage. Modal forms, infinitives and deletions, count 1 point, the same score as negatives and noun modifiers such as adjectives and possessive nouns. Passive transformations, infinitives as subject and conjunctive adverbs such as *thus*, *however* and *therefore*, count 2 points, the same scoring as comparatives, adjectival clauses and participles. They allocated their highest score, 4, to noun phrases set off by commas [Quirk & Greenbaum 1973 pp. 276-283], a form which appears in science textbooks associated with definitions. Clauses as subject, also common in science writing, score 3 points.

3.5.4 Nominalisation, noun phrases and infinitives

Halliday [Halliday & Martin 1993 pp. 116-118] traces the use of nominalisation in language, where verb forms are converted into nouns, back to the beginnings of Greek scientific discourse around 550 BC, and to the development of writing. He identifies "*a kind of lateral shift*" inaugurated in Newton's writings, leading through a steady unbroken evolution, to the scientific English of today. He refers to nominalisation as "*grammatical metaphor*" and "*objectification*". Processes are "*grammaticalised as things*" in order to reason within clauses. Nominalisation creates a kind of shorthand which makes conceptualisation easier. It enables processes to be classified and organised as things [1993 pp. 13-18, 52, 213, 228, see also 3.4.4 in this chapter]. However, he also discusses whether the use of nominalisation in scientific discourse is a question of function or status and explains that it creates meanings which are "*less negotiable*" [1993 pp. 39-41, 217]. Clauses, infinitives and noun phrases, as subject, perform a similar function in scientific writing.

Daugs and Daugs point out that reading difficulty increases with the use of infinitives and passives [1974 p. 481]. Perera [1986 p. 60] suggest that the use of noun phrases is a very good indication of style. There are four times as many complex subject noun phrases in scientific writing as there are in fiction. These phrases are also longer in scientific writing than in fiction. Perera [1986 p. 61] points out that this structure can cause reading difficulties and is particularly demanding of slow readers. Halliday [Halliday & Martin 1993 pp. 68, 79-82] identifies the difficulties which students have with grammatical metaphor, linked with lexical density and syntactic ambiguity and sees them as developmental problems. It is an unfamiliar written form of language. Perera [1984 pp. 293-294] examines ways of avoiding nominalizations and suggests that this is worthwhile.

Although they cause students difficulties, the author considers the use of nominalisation, noun phrases and infinitives important tools in scientific thought. They enable the manipulation of processes within theories, as things. As such, students ought to be introduced to them as part of a *scientist's toolkit* within a science course. However, this should be done sensitively and with due regard to accompanying language complexity. In cases where the inclusion of such features is down to assumed status, or is unnecessary to the scientific argument, they should be rooted out. It is difficult to make a similar case for the inclusion of passives.

3.5.5 Implications of problems with scientific grammar

Grammar influences understanding at the whole sentence or whole text level. Misunderstandings of the grammatical features of scientific text are thus more important than individual words mistaken and can be crucial. The grammar exerts much of its influence through verbs, action words which operate at the whole sentence level. Most of these verbs are Standard English words which organise the argument and are thus essential to its understanding. Unfortunately, scientific grammar uses these verbs in unfamiliar forms such as passives, modals, infinitives and nominalisations which are little used in the students' common speech and literature. Scientific lexical verbs have specific technical meanings which are thus, paradoxically, easier to guess from their context. Scientific lexis uses nouns to name things. Even if a student mistakes one technical noun in a sentence, enough of the message may be understood for them to understand the text as a whole from the context. Nominalisations derive from verbs and describe processes. They are abstract concepts and are more difficult to guess from context. Technical nouns may carry less meaning than nominalisations of familiar words and may thus have qualifying adjectives, which help the student. It may be easier to work out the meaning of an unfamiliar technical word than the unfamiliar, nominalised form, of a familiar verb used in a metaphorical context.

3.5.6 The need for scientific grammar

The argument traced the reasons for the form of scientific grammar to the nature of the scientific enterprise and then examined the manifestations in scientific text. It is not surprising that scientific grammar is unfamiliar to some students. In a study of students' learning about communication in science, Lemke [1985a, p. 17] concluded that scientific discourse sustains,

> "*an ideology of science as alien to and above the human world of common discourse in which students, and all of us, feel comfortable and confident*". "*Science deals with facts and proofs rather than opinions and beliefs.*" [Open University 1987 p. 15, see also Appendix B Transcript 10111 lines 083-107].

In the author's view, there seems to be little point in insistence that students accept the impersonal nature of scientific discourse. The language may not be familiar and may challenge spontaneity, interest and enthusiasm. There might be a conflict between a more personal form of expression and the disembedded nature of scientific thought, but this could be accommodated. A reductionist, disembedded, approach is typical of the science register because it is related to the nature of science and should not be discarded. However, it can be tempered through appropriate contexts and issues.

Students could be released from the complications arising from the generic use of the definite article, the third person and the passive voice. However, modal forms, verbs like *seem* and *appear* and some unfamiliar constructions, along with nominalisations and noun clauses are important features of the science register which convey the nature and philosophy of science. These features should be retained and taught together with an understanding of scientific illustration. Textbooks and worksheets have an important role to play in teaching students about scientific discourse [see Halliday & Martin 1993 p. 167, Bulman 1985 pp. 50-51]. Scientific grammar might pose both linguistic and cultural problems for the bilingual student.

Martin [Halliday & Martin 1993 p. 194] sees patterns of writing such as those expressed by the passive voice as, "*crucial to the effective write-ups of experiments*". He points to a number of research studies [Rothery 1986, Christie 1988, Collerson 1984] which demonstrate that children can be introduced to "*factual writing*" from the beginning of school. Bartov [1981] suggests abandoning the active voice altogether. The author disagrees with these positions favouring West's view [1969] that what a student does and sees is unique to them at the time it occurs. It follows that a student's report should be a "*unique communication*". Experiences can then be generalised with a sense of involvement of the participants. Generalisation is essential to communication and effective communication leads to effective learning.

> "*Freedom for the child to express his experiences in his own language must come first*" [West 1969 cited in Rosen 1971 p. 153],

the language used may not in itself be scientific but it will be used in the context of scientific experience. Out of this can grow the true language of science. It is the role of textbooks to provide models of language for students to follow in their own science writing [see Davies 1986 p. 103 cited in Chapter 2: 2.5.1].

3.6 Scientific lexis

The science register involves specialist vocabulary including specific meanings for familiar words and specialist language constructions. Non-technical words are too imprecise or circuitous to replace essential technical words. However, as Perera [1982b p. 120] points out, "*jargon*" is not essential to clear concise thinking it simply replaces one word with another.

> "*The register of scientific English exerts a powerful influence on the language of science teachers in spite of their attempts to adapt their language to the needs of the pupils.*" [Richards 1978 p. 91, e.g. Appendix B Transcript 10111 lines 146-158].

Daugs and Daugs [1974 p. 471] and [Evans 1974 p. 585] observe that learning science involves learning as many new words as learning a foreign language. Richards [1978 p. 90] compared the language demands of different subjects by counting the technical terms, words or language forms presented in five different lesson. The sciences came out on top with over two hundred technical terms each, and in the case of biology, 63 special non-technical terms. This was more than double the tally for geography, three times that for history and four times that for languages. A study of biology textbooks used by fifteen year olds in Canada [Daugs & Daugs 1974 p. 481], found that reading difficulty increases as vocabulary becomes more abstract. In subjects such as sciences where technical vocabulary is essential,

> "*it is all the more necessary for the structure of clauses and paragraphs to be as helpful as possible for the reader.*" "*If unfamiliar subject matter expressed in technical vocabulary combines with intrinsically demanding sentence structure, then the chances of full comprehension are much reduced.*" [Perera 1984 p. 275].

Richards [1978 pp. 104-119] researched the development of science register use in students. Her work showed a gradual shift towards more use of science register terms and expressions, as students progressed from age 7+ to age 16+. Such progression is reflected in National Curriculum levels of attainment [DESWO 1991] discussed earlier in this chapter (see 3.2.5 , Appendix D). Chapman and Louw [1986] describe register development as,

> "*akin to that of a foreign language learner whose language begins to approximate to and approach the target language.*" [Chapman & Louw 1986 p. 19].

Corder [1974] refers to this process as "*transitional competence*" and Chapman and Louw [1986] refer to "*interregister*". Such models pose serious problems for the learner of a science register which is full of precise definitions and subtle variations in meaning. Chapman and Louw [1986 p. 22] concluded that full sensitivity to registers may not be completed by the end of secondary schooling and talk of "*register clash*" and "*mode lag*" in understanding written registers. However, Myers [1991 p. 17] talks of "*building bridges between two registers*" by defining or marking terms. Children are influenced by early exposure to literary text when trying to make sense of other registers. As explained in Chapter 2 (see 2.6), children have a sophisticated understanding of literary fiction registers. Although children are motivated by a desire to be "*in register*", there was also evidence of a "*retreat from print*" where factual texts were concerned [Chapman & Louw 1986 p. 22]. Perera [1982b] suggests that technical vocabulary needs to be learnt slowly with opportunities for experimentation in "safe" situations, Jeffs [1980 p. 193] suggests "*contextualisation*". Perera [1982b p. 121, Prestt 1976] also points out that printed forms do not allow the dialogue a student needs to have to make new terms their own.

This discussion is a case for well thought out work on science text in science lessons which acknowledges the difficulty of a student's precise expression whilst they are developing their knowledge of, and experience of using, this new form of language. The use of text related activities such as DARTs [Davies & Greene 1984] and vocabulary building strategies [e.g. Stieglitz & Stieglitz 1981], co-ordination with English colleagues as suggested in Chapter 2 (see 2.6.1) within a policy of language across the curriculum and commitment to linguistic repertoire development, as discussed in this chapter (see 3.2.2), would address some of these issues. It is debatable whether all students will need this technical scientific vocabulary and scientific nuance of meaning in their life after leaving school and some teachers would argue for greater emphasis on students' articulation of principles using ordinary language. In Sutton's view [1994 pp. 14-15], by treating language as a means of "*sharing interpretation*" rather than "*labelling*", for "*interpretation*" rather than "*transmission*", teachers give students a "*better insight into the nature of the scientific enterprise*". The author favours developing linguistic repertoire and scientific thinking in all students, an objective which requires a sensitive approach to scientific lexis involving introducing it, when it promotes understanding, in manageable amounts.

3.6.1 Vocabulary and conceptual difficulty

As Harrison [1979] points out,

> "*Particularly in chemistry and biology, the high number of specialist terms creates special difficulties for the reader*" [Harrison 1979 p. 85].

However, as Adams & Bruce [1982 p. 6] explain, less common words are more informative than common ones because their meanings are more specific . Learning vocabulary is a necessary evil in learning science. Evans [1976 p. 30] suggests that all terms should be explained and emphasised on their first appearance and that they should be included in a glossary. This implies the sequential use of textbooks which is quite prescriptive. Perera [1984 p. 277] suggests that unfamiliar words help readers predict subsequent content and vocabulary and should be introduced early in a passage. Evans [1976 pp. 19 & 26] also urges that authors should not assume that students are familiar with terms from their studies prior to Key Stage Four. This situation may change with the implementation of the National Curriculum.

Dangerfield [1981 pp. 546-548] studied GCE and CSE science textbooks. The average reading ages were 17+ for his GCE group and 14.6 for his CSE group. However, none of the students scored in the *independent* reading level using cloze procedures (cloze procedures are discussed in Chapter 6: 6.3.3-6.3.5). The students' results on an APU standardised vocabulary test suggested that they had the vocabulary required for usefully reading material written for their age group. In common with the views of many teachers to whom the author has spoken, Dangerfield concluded that specialised vocabulary could be a major difficulty with science texts. However, his findings may be due to students' difficulties experienced at the whole sentence and whole text level associated with scientific grammar.

Some languages have technical words of their own and in these cases a mother tongue/English dictionary and translation are of use to bilingual students (see Appendix A Schools 1004 & 1019). However, as Solomon [1987 pp. 74-75] points out, concepts and meanings generally overlap in different languages rather than match exactly. In some countries English is the language of science [Chatterjee 1993 p. 5]. The possible imprecision and lack of standardisation in local forms of a language is discussed earlier in this chapter (see 3.2) [see also Chatterjee 1993 p. 5 on Bengali and other Indian languages, Khatete 1994 p. 5 on Kiswahili, Opeola 1985 p. 234 on Nigerian languages and the need for a "*lingua franca*"]. Even when steps have been taken to speed up the development of a science register in a language (e.g. in Israel, Malaysia, and Tanzania) as described by Strevens [1976 p. 58] or in situations where local languages are considered adequate described by Kulkarni [1988 pp. 152-153], there are problems in incorporating the features of scientific discourse which are unfamiliar and involve social and cultural realities. Mother tongue teaching or translation may, at present, be inappropriate with these languages. There is a problem when students think in one language and talk science in another if,

> "*they tend to think in their mother tongue and translate their ideas literally into English.*" [Khatete 1994 p. 4].

3.6.2 Lists of words

Cassels & Johnstone [1980, 1985, Johnstone 1988 p. 20], have produced lists of science words "*which need special care and attention*". Some of this research indicated that the problems of transmitting science,

> "*lay not so much with the technical words but with common words which changed subtly as they moved into science*" [Johnstone 1988 p. 19 see also Evans 1974 p. 587, Solomon 1987 p. 75].

Evans [1976 p. 19] urges authors to reduce the use of synonyms in technical vocabulary. This is redundant and confusing. Biological technical language labels totally different structures which perform the same function, with the same word. For instance, *thorax* and *trachea* describe different parts of mammals and insects. Evans [1974 pp. 585-587] also discusses difficulties connected with prefixes and suffixes. The context in which words are used also has an effect. Students lack precision in words as they move from context to context, they are,

> "*easily confused by "sound alike" and "look alike" words*"and sometimes they "*chose meanings exactly opposite to the accepted meaning*" [Johnstone 1988 p. 23].

3.6.3 Scientific meanings and scientific words

As is typical of new meanings for words, many scientific meanings are metaphorical in origin, such as *vein, charge* and *battery.*

> *"Metaphor is both ubiquitous in all linguistic activity and essential to social life and to conceptual activity. In science, and in all attempts to construct knowledge, metaphor is a necessary strategy. It provides the means to step from the known to the unknown"* [Kress 1985a p.72].

When further knowledge is gained as science progresses, these metaphors are sometimes found to be totally inappropriate, yet the new term lingers on because it has currency within scientific discourse. Once a term has been *accepted* it is *defined.* Such a definition can then be redefined as more knowledge is gained. Eventually the word is distanced from the original metaphor and becomes totally distinct. Halliday [1978 p. 195] calls this process *"reinterpreting existing words"*. With some words, different branches of science come up with different definitions e.g. *vein*. Many words are defined in different ways in different school subjects e.g. *energy*. By a similar, but *reverse* process, some scientific meanings of words such as *diet* have become through common usage to mean something less precise than, or different from, their scientific meaning. Such *lexical confusion* may make the task of understanding language in science very difficult.

Many biological words were coined during the neo-classical age (1750-1900) when Greek and Latin forms were the language of scholars and some professionals [see Leith 1983b p. 54] e.g. species names such as *Turdus musicus* [see Halliday & Martin 1993 p. 196]. These words have special, sometimes metaphorical, meanings for the classical scholar or include pseudo-classical forms (Spartina *townsendii* celebrates a scientist, see 3.4.2) maintaining the exclusivity of scientists. Latin and Greek forms create unfamiliar words like *photosynthesis, duodenum, xylem, phloem*, and unfamilar word endings like *-ii*, *-us* and *-a*. For many students these words follow unfamiliar rules when creating plurals and translating nouns into verbs and adjectives. Common words with classical roots such as *dictate*, *school* and *send* benefited from regular usage in everyday discourse. There are fewer reference points and chances to practice with scientific words where, in addition, usage is precise. However, some of these forms are distinctive and easily remembered. Their use underlines the eurocentric nature of science.

3.6.4 Evolving language

Culler [1986 pp. 22, 35-37] describes how language is constantly evolving and how new meanings of words are reinforced through usage. Language continues to change,

> "*because that's the only way it can persist*" [Halliday & Martin 1993 p. 108].

One problem with the definition of words within science is that it is an attempt to halt this evolutionary process. Words and phrases within common usage change their meanings over time, for instance the modern usage of *out of order*, *sonic* and *supersonic*. It is the business of science to have precise definitions which do not change until there is a fundamental reassessment of the concept agreed by the scientific community [see Kuhn 1970]. Science is thus in the same danger as the Law and other conservative institutions of finding itself using archaic language which has fallen out of common use, e.g. *niche* and *parasite* [see Sutton 1992 prelude to Chapter 2, p. 22].

3.6.5 Taxonomy and classification

Scientific activity involves classifying and naming observable features in natural phenomena. Kinneavy's [1971 p. 36] "*classificatory*" "*mode of discourse*" is dominant because it facilitates induction [see also Hutchins 1977 p. 25, Halliday & Martin 1993 pp. 170-173] enabling the formulation and discussion of the laws and generalisations which are the backbone of scientific theory as explained in section 3.4.3. Scientific lexis encapsulates the classification system. Halliday [Halliday & Martin 1993 pp. 73-74] acknowledges the problems which students have with technical taxonomies. The important role played by general nouns, superordinates and synonyms in the cohesion of text was discussed in Chapter 2 [see 2.3.4, Halliday & Hasan 1976 pp. 274-282]. Perera [1984 p. 320] highlights the difficulties arising from a failure to recognise such lexical relationships which are often confounded by ellipsis. Classification within a text makes sentences more complex by introducing subordinate clauses and noun phrases as was noted earlier in this chapter (see 3.5.3, 3.5.4). Some scientific group classification words such as *animal*, *insect* and *plant* have less specific meanings in common parlance. As Bell & Freyberg [1985 p. 31] point out, students may have difficulty identifying *insects* as a subset of *animals*. Villalbi and Lucas [1991] have demonstrated that this classification is less of a problem in Catalan and Castilian Spanish where there is less distinction between the everyday and scientific meanings of the words. Tema's work [1989] in Bophuthatswana, South Africa, showed that in a situation where the home language (Setswana), differed from the language of instruction (English), most students classified animals correctly.

Words such as *organism* and *mammal* often occur in textbooks without explanation because they are common general words in scientific discourse. *Organism* is rarely used, if at all, in common parlance where *animals and plants* stresses the common sense view that there are more differences than similarities between the two groups. Further, common sense does not agree with science on the words *animal* and *plant* [Bell 1981, Bell & Barker 1982, Bell & Freyberg 1985]. Halliday and Martin [1993 pp. 173-175, 207-208] also discuss *"part to whole"* classification or *"composition"* which plays an important role in science. Examples are cell components and insect body parts.

Scientific species names classify into groups and subgroups within the unifying evolutionary theory e.g. *Canis familiaris*. Kripke [1972 pp. 255, 330] describes this distinction between John Stuart Mill's *"denotation"* and Frege and Russell's *"description"*. Such descriptive names provide greater precision in naming than is usually required in general conversation, facilitating deductive thought by avoiding the semantic pitfalls reviewed by Kripke. The theoretical content is a sort of shorthand which may make the information presented more manageable but less accessible (see 3.4.4). A difficult, controversial theory is assumed and non-negotiable. It imposes rules on classification and requires generalisations (see 3.4.3), not *prototypes*, implying a reliance on instruction rather than prior knowledge. Leach and Scott [1995] have shown that students find generating such generalisations difficult, a problem not always recognised by teachers. They point out that there may be a mismatch between everyday explanations and such scientific generalisations. The science register uses everyday words such as *animal* in a descriptive sense whereas everyday language uses them in a denotary sense.

Classification systems evolve as scientific thought develops. Established names can become inconsistent or counter intuitive. Students may not share the taxonomist's view on relevant distinguishing features. Students may perceive generalisations through exemplars rather than as the nested generalised concepts described by Smith and Medlin [1981]. They may prefer previously learned [Halliday & Martin 1993 pp. 137-143] or application/context linked [Layton 1991 p. 67], pragmatic taxonomies. Compare the apparent differences between the house sparrow *Passer domesticus* and the hedge sparrow *Prunella modularis* with the differences between the blackbird *Turdus merula*, field fare *Turdus pilaris*, red wing *Turdus musicus*, and thrush *Turdus philomelos*. Smith and Medlin [1981 pp. 30-31] and Sokal [1984] argue that biological classification follows the "*classical view*" of categories and concepts, featuring nested subsets and emphasising physical attributes, criticised by Wittgenstein. Problems in defining the "*essence*" of taxonomic groupings cause some scientists to question its validity.

Halliday and Martin [1993 figs 8.2, 8.3 & 8.4 pp. 140-143] considered the lay people's, bird watchers' and scientists' taxonomies for birds of prey. The first loose classification, and the second classification which identifies species from field-observable characteristics including behaviour, need not follow the rules of the classical view. Some students bring these resources to the classroom, a "*very useful starting point*" [Halliday & Martin 1993 p. 170] but an "*alternative framework*" [Driver, Guesne & Tiberghien 1985 pp. 9, 34, 86, 140]. The scientific taxonomy reflects an evolutionary view of inter-species relationships placing each species within a larger scheme ruled by theory [Halliday & Martin 1993 pp. 168-169, 204-206]. The name carries *a weightier message*. The taxonomies operate "*on a cline of needing to know*"[Halliday & Martin 1993 pp. 141, 163]. There is more to understanding this scientific terminology than simple translation and it should not be taught as such.

3.7 Scientific language and thought

There are clear links between the "*propositional and hypothetical thinking*" characteristics of Piaget's formal operation stage of cognitive development [Furth 1970 p. 33], and the type of thought required for scientific discourse [Flower 1980 p. 196]. So one might conclude that the accessibility of science textbooks is merely a developmental problem. In Stanard's [1993] view,if the majority of readers are at the *concrete operational* stage of development, then the argument should be pitched at that level. Certain features of the science register may cause readability problems. A student could reach Piaget's formal operational stage of development yet be unable to receive or transmit thoughts characteristic of this stage because of a breakdown in language communication. A sceptic would argue that such a student would need language to explore formal operational thinking [Wood 1988 p. 6, pp. 23-24]. However, such a student might be able to express their formal operational thinking in an alternative language or semiotic system such as mathematical or graphical representation, or in the case of bilingual students, in another language. In Bruner's [1986 p. 127] and Vygotsky's view [Wood 1988 p. 10], language is crucial to learning and development as the medium of social communication at the heart of learning [Wood 1988 pp. 26-29, Gatherer & Jeffs 1980 pp. 62-63]. Learning is a cultural experience. The hypothetical bilingual student could have one language at the heart of their learning development outside the classroom yet be limited in intellectual expression in another, the language of classroom interaction. Bruner's and Vygotsky's theories imply the greater importance of factors such as *reader's position*, selection of examples of good science, and *context* as it relates to both text and figures, in the accessibility of textbooks to bilingual readers. From either point of view, language is important and potential may lie undeveloped in bilingual students. A Piagetian textbook would set the scientific discourse out in the language of formal thought (the traditional genre). Vygotsky's textbook would enter into a dialogue with the student, like a "*more knowledgeable peer or sibling*" [Wood 1988 p. 25] accounting for varied cultural experience.

3.7.1 The language of school science textbooks: a model

A layered model of the language used in science textbooks which is similar to the "*semiotic communication planes*" model [Littlefair 1991 pp. 85-86, 1988 p. 133, Ventola 1987 p. 85] emerges from the discussions in this chapter (see Table 3.1). The base level is Standard English. The science textbook uses scientific lexis. This mixture of Standard English and scientific lexis is organised into meanings expressed at the whole sentence and whole text level which incorporate the hypothetical, impersonal, deductive and disembedded nature of the scientific enterprise. This next layer of meaning is scientific grammar. These three components contribute to the science register which is expressed through a particular genre which introduces a political, social and cultural dimension to the text. The author's/publisher's writing style applies a final gloss to the text. There is an important social, political and cultural link between Standard English and the genre of the scientific textbook. Accessibility operates at all of these levels of meaning.

Table 3.1: The language of school science textbooks: a model

LEVEL OF ORGANISATION	IN SCHOOL SCIENCE TEXTBOOKS	EXAMPLES OF FEATURES AFFECTING ACCESSIBILITY FOR READERS
WRITING STYLE	House style & writer's style	Selection of unfamiliar words. Unfamiliar phraseology, punctuation & sentence length. Role borrowing (switches between the science register and forms of Standard English intended to be more "familiar").
GENRE (Whole text including figures.)	Science Textbook Genre	Cultural implications of SE. Use of teaching discourse, Code switching, introductions, and definitions. Reader's position, power of the speaker (author). The authoritative stance assumed. Eurocentric, sexist attitude to scientific achievement. Selection of contexts. Images of people portrayed. Links with a Vygotskyan approach to teaching and learning.
SCIENTIFIC GRAMMAR (Sentences & groups of sentences including syntax. The semiotics of figures.)	Science Register (Grammar)	Impersonal, eg. the generic use of the definite article. Disembedded, hypothetical & deductive. Scientific word constructions. The passive voice, modal verbs and nominalisations. The grammar of scientific figures. Links with a Piagetian approach to teaching and learning.

Table 3.1 continued

LEVEL OF ORGANISATION	IN SCHOOL SCIENCE TEXTBOOKS	EXAMPLES OF FEATURES AFFECTING ACCESSIBILITY FOR READERS
LEXIS & DIALECT (Words & phrases. Symbolism & convention in figures.)	Science Register (Lexis)	Unfamiliar words with precise meanings. Obscure coinage of scientific words. Fossilisation of language. Latin & Greek derivations which do not follow normal word rules. Classificatory roles of words. Common words with specific meanings. The "lexis" of scientific figures.
	Standard English	The codified, "rule governed", precision of Standard English.

3.7.2 A network of assumptions

As Stubbs [1983 p. 84] points out, most sentences have multiple meanings in isolation but hearers make sense of them through reference to context. However,

> "*The whole point of a passage may be lost if the reader or listener does not bring to it appropriate assumptions derived from the context of situation.*" [Halliday & Hasan 1989 p. 46].

Winser [1994] describes,

> "*prediction, the supplying of elements from the text by supposition*" as "*the main reading strategy available to readers*", "*the most fundamental language strategy of all*" [Winser 1994 p. 18].

One function of the levels of organisation of language is to provide the context for the written text. They thus contribute to interpretation and meaning. The levels of organisation provide a system of levels of classification which defines, for the reader, the assumptions they should make in reading the text. Standard English implies that this text has a certain status. For many Standard English is only a written form. The use of scientific lexis suggests technical correctness. Scientific grammar, is even more exclusive. It classifies the text into that small group of texts involving the work and philosophy of science and scientists. The genre pins the text down further, defining the relationship between reader and writer, the institutional use of the text and the influence of a particular culture. Both the context and the assumptions are highly defined. The writing style provides the final level of text interpretation. The schema discussed in Chapter 2 (see 2.3) which inform these assumptions are comprised of information and experience from various sources. Standard English is encountered in most school subjects and in some students' home and playground talk. Pupils learn about the science register through reading, writing and listening in science. They learn about the genre from experience in using science textbooks in general and they pick out features of style through using a particular textbook regularly. If the reader reads the context correctly, through this classification, they can make correct choices of meaning in their reading of the text. In other words, the levels of organisation of the text transmit a considerable amount of information about the meaning of the text. This matter of reading the context through interpreting semiotic planes does not necessarily imply understanding the meanings of individual words, it concerns the range of possible meanings for individual words from which the reader subsequently chooses. A reader may identify scientific lexis, scientific grammar, school science textbook genre, or writing style, in a text without necessarily understanding the meanings of the words used. Unfortunately, as Adams and Bruce [1982 pp. 9-12] point out, a large part of the author's clarification of meaning involves hidden messages embedded in the text. The final choice of meaning of individual words and phrases is the result of interplay between the assumed context, the science textbook schema and the choices of meanings available to the reader. Thus the final choice of meaning depends on prior experience and study skills in addition to context interpretation.

This author has put forward a complex system of meaning embodied in the text. This argument outlines a *semiotic meaning making task* required of the reader in advance of their coping with questions or activities based on the text. When they attempt this task for homework, students have restricted access to teachers or peers. Some students take no action on these messages hidden in the organisation of the text. Presumably, they fail to notice these messages, cannot read them, choose to ignore them, or can read them but are ill equipped to implement them through lack of experience or understanding. Bilingual students could fall into any of these categories due to difficulties arising from language or culture. Unless students are taught about science text and how to decipher these hidden messages, it is unlikely that some of them will access it efficiently.

This theoretical position predicts that the final choice of meaning of individual words is not completely dependent on the interdependence of the components of school science textbook language because it is also dependent on other factors such as prior knowledge and study skills. However, as prior knowledge and study skills are constant factors during the reading of a text, the theoretical position does predict the consistent contribution of the components of school science textbook language in the understanding of a particular text amongst students of similar experience.

3.7.3 The science register and classrooms

Halliday's definition of register [1978 p. 35, Halliday & Hasan 1989 pp. 41-43] links it to "*use*", "*determined by what you are doing*". He says, "*occupational varieties*" are "*typical instances*" of registers. The science register then, is the occupational variety of Standard English used by scientists. It is closely linked to the hypothetical, deductive, disembedded nature of the science enterprise. Kinneavy [1971 p. 36] describes the science register is a language of doing, of acting, a language of explanation, speculation and implementation rather than a language of description. This view of scientific language is consistent with a "*realist*" philosophy of science expounded by Bhaskar [1978] and others [e.g. Hacking 1983, Harré 1986] which, as Driver et al [1996 pp. 40-41] point out, is held by most scientists. To understand scientific words it is not enough to define them or associate them with a limited set of identifying features. As discussed earlier, students need to relate them to functional aspects [see 3.2.6, Carré 1981 p. 12-13, Nelson 1974]. Biology may be descriptive but the descriptions (e.g. of species and anatomy) are used in explanation or speculation about function. For example,

> "*They have a number of fins which enable them to swim upright.*" and "*They have a dry scaly skin, which is waterproof.*" [NCCT 1988b pp. 24-25].

The naming of things in science may classify them within scientific laws and generalisations or may confer that precision which facilitates detailed explanation and classification. This emphasises cohesion, the place of *superordinates* and general nouns. In Chapter 2 (see 2.3.4) cohesion was highlighted by Leonardi as an important factor in understanding for second language learners. The generic use of the definite article is another form of generalisation promoting patterns within information. The *disembedded* nature of the science register is a form of generalisation where the writer, assumes interpretation skills in the reader. The language forms arising out of the hypothetical, deductive nature of science are directly linked to the active, explanatory, speculative nature of scientific discourse. The discursive patterns in scientific discourse are vital to the activity and explanation of scientific advance. The impersonal nature of the science register is a convention which is intended to bring the science to the fore rather than the personality of the scientist. It is reminiscent of Eighteen Century writings and may be an example of the archaic forms which, as suggested earlier, could be discarded (see 3.5.6). However, it places emphasis on scientific activity rather than personalities.

The science register performs a useful function in the scientific world by enabling the flow of ideas between professionals. One wonders if it is asking to much of it to perform equally well in the classroom. However, Martin [Halliday & Martin 1993 p. 222] claims that classroom texts are good examples of scientific discourse. Zylbersztajn [1983] points out that, if scientific discourse involves explanation, speculation, implementation and description, school science can only be a very partial derivation of *real* science. Driver et al [1996 pp. 141-143] trace "*the restricted epistemological perspective being portrayed in science lessons*", which fails to reflect the breadth of true scientific enquiry, to the National Curriculum for Science [DESWO 1991]. Perhaps in this context, the science register is expected to do a job which it was never designed or developed to do. Much of the science of the classroom is descriptive, not open to discussion and is predetermined [Lemke 1989 p. 33]. Scientists would discuss matters, described and explained in the classroom as fact, without anticipating the outcome. Students read descriptions of activities from which they are detached and disinterested, written in a science register which scientists use to discuss matters which they are actively involved in. It would be impossible to adopt the genre of the scientific paper as described by Hutchins [1977] in a textbook designed for classroom use. Perhaps some of the features of the science register are just as out of place. As Lemke [1989 p. 33] points out, as things stand, students and teachers are encouraged to blame themselves for an inability to make sense of the language they are expected to use, rather than to probe the usefulness of the language of science in the classroom context. Driver et al [1996 pp. 39-40] discuss the non-realist philosophical accounts of science of non scientists such as Polyani [1958] and Ziman [1978]. It seems desirable to this author for science education to include some of this non-realist thinking about science and scientific issues, for which the science register may be a hindrance rather than a help.

One solution might be to make science education more active and more *like real science*. This approach does not necessarily mean teaching *the nature of science* or *the lives of great scientists*. That is the kind of solution proposed by Sutton [1994] with his emphasis on "*authorship*". Neither should science teachers abandon content in favour of a *process* approach to science with its emphasis on investigative work. Scientists still collect information from books and other sources for use in research and they are, therefore legitimate sources of information for students. The author would abandon the science register for the descriptive part of school science and use it only when it was intellectually and philosophically necessary. He would make science education more deductive and speculative, presenting alternative explanations of observations in textbooks, not necessarily by including more science register in textbooks. Perhaps a form of scientific discourse could be conducted between students in the classroom using textbooks as sources of information which inform active investigation. The role of the teacher would be to help students to understand what scientific discourse means and how it works. In the author's view it should be possible to cut out a lot of the archaic nonsense in scientific discourse without losing the investigative hypothetical language which students need to engage real scientific activities. Once practised, perhaps they will be in a better position to read and understand texts which use scientific language extensively.

The science register should be used for a pedagogical purpose, rather than to impress, or to express power or influence. Students' understanding of the science register would be improved by talking it in the classroom, reading about it in textbooks and doing activities aimed at making meaning of it. The science register performs important functions in the expression and development of scientific thought, it can contribute to an understanding and appreciation of scientific thinking. A working knowledge of it can make scientific reading and thinking more interesting, more relevant and more enjoyable.

3.8 Summary

Scientific language and graphical representation is distinctive and arises out of the nature and history of the scientific enterprise which involves hypothesising, finding patterns in observations and precise expression. As Sutton [1992 Chapter 7, 1993b, 1994, 1996] points out, scientific language is "*interpretive*" compared with the "*labelling*", "*transmission*" form of language with which some students are more familiar. All three components of the science register contribute to its interpretive function. There is the codified, universality of Standard English, the precision of scientific lexis and the hypothetical, deductive nature of scientific grammar. In the author's experience, science teachers and textbooks generally work hard on scientific lexis. Unfortunately, this is sometimes from a distinctive, *labelling* or "*transmission view*" [Barnes 1976] standpoint. The use of Standard English is addressed within the curriculum though not specifically in science. From the author's experience, scientific grammar is the aspect of the science register which is probably most neglected in schools. The message of science textbooks is expressed through a register, genre and styles which are unfamiliar to many students and which imply particular assumptions in interpretation. This use of language and network of assumptions presents problems for many students both bilingual and monolingual.

The chapter raised various issues concerning the use of the science register in school science textbooks. Many students' problems with the science register may reside in an author's assumptions of their understanding of subtleties of meaning at various levels within the text. The need for the conventions of scientific grammar in purely descriptive passages was questioned. They could be written in simple plain English. Such texts should be the raw materials for scientific discussion where the grammar is appropriate. Approached in this way, students would be encouraged to learn and experiment with scientific grammar in manageable amounts. This links with some of the ideas about using text in the classroom and the broader issue of text interpretation discussed in Chapter 2. If the detailed explanation and definition of scientific lexis in textbooks is justified, then surely there is an equally valid case to be made for the careful introduction and explanation of scientific grammar. It is the duty of scientific textbooks to demonstrate the effectiveness of the science register when it is used in an appropriate intellectual context. Students should learn to view it as a powerful tool in practising scientific thought rather than as a hindrance to understanding. This requires careful consideration of the purpose of particular texts within a textbook at the writing stage. Many devices are available to authors to signify the different purposes of different pieces of writing (e.g. making an original description of an experiment appear to taken from a Victorian scientist's laboratory notes).

Resolving these issues implies reforming the genre and style of school science textbooks. The rest of the thesis describes research in students' understanding of the genre. writing style, scientific lexis and scientific grammar found in a school science textbook with particular reference to bilingual students. The view of language developed in this chapter emphasises the assumptions embedded in text and the elucidation of meaning through predictions on various semiotic planes. This argument links with the discussion of text schema and prior knowledge in Chapter 2. Consequently, the practical research described in the second half of this thesis employed a cloze procedure which measured students' understanding through their prediction of meaning.

Chapter 4: The school-based research

4.1 Introduction

The previous chapters explained the *theoretical framework* which supports the study. This chapter introduces the detailed description of the study including the collection and analysis of data which comprises the second part of the thesis. A *research agenda* was developed in response to two research questions, linked with the theoretical framework. The development of a research agenda led to the selection of appropriate methodologies which are described in use in the following chapters.

4.2 The research questions

Understanding science involves learning the language of science, its register and discourse, and how to use it. The study examines two propositions. First, that bilingual students are advantaged in learning this new language because they possess additional linguistic resources. Secondly, that bilingual students are disadvantaged in learning the language of science due to limited exposure to English, and opportunity to experiment with it.

Two research questions arise from these two propositions.

* Do monolingual and bilingual students have the same problems with school science textbooks?

* Is bilingualism an advantage or a disadvantage to students dealing with school science textbooks?

The research focused on identifying the circumstances in which bilingualism is an advantage or a disadvantage in the accessibility of school science textbooks. The identification of these circumstances was achieved through studying the use of a school science textbook in science classrooms. The role of scientific language was given particular attention.

The Nuffield Co-ordinated Sciences Biology textbook was chosen for study because its publisher offered limited support to the research. A detailed study of this textbook was carried out. The publisher provided a database listing schools using the textbook and the means of contacting them. Through these channels, volunteers were found who were prepared to participate in the study. Information was collected about the schools which took part from interviews, prospectuses, Ofsted reports and other sources. Information about the textbook and its use was collected from students and teachers through, interviews, questionnaires and cloze tasks. Readability, figures, grammatical and other studies of the textbook itself were also carried out. The data collected were analysed and discussed.

The argument put forward in Chapter 1 (see 1.2.6, 1.2.7) suggested that the extent of second language use within bilingual communities might affect students' understanding of school science textbooks. The study should therefore take the *institutional environment* of the use of these textbooks into account. The *pedagogical context* of school science textbook use was described in Chapter 2 as a factor which might affect bilingual students' understanding of school science textbooks. Consequently, the study should consider the *classroom context* in which these textbooks are used. The *linguistic features* of both written and graphic scientific text were discussed in Chapter 3 as factors which might affect the accessibility of school science textbooks to bilingual students. It is therefore important for the study to investigate the *accessibility of the language* of school science textbooks. *Taking account of institutional environments, considering classroom contexts* and *investigating the language accessibility* of school science textbooks with particular reference to bilingual students became a *research agenda* for the study.

4.3 The study

The Nuffield Chelsea Curriculum Trust and later the Nuffield Foundation , provided limited support for the research on the understanding that the Nuffield Co-ordinated Sciences Biology textbook was studied as an example of a school science textbook. The organisation of the research methodologies used to study the accessibility of this textbook to bilingual students followed Halliday's division [1978 p. 33] of "*what is linguistically significant in the context of situation*". He identified the "*field*", or institutional setting, the "*tenor*" or relationship between participants and the "*mode*" or channel of communication. Consequently, the accessibility of the textbook studied to bilingual students, was considered from three perspectives, as a *contributory factor to student performance on tasks* (field), as a *judgement by students and teachers* (tenor) and as a *property of the textbook* (mode).

A distinction was made between the *readability* and *accessibility* of text. Both terms refer to the difficulty which readers experience in understanding a text. However, whereas readability describes the text without reference to the circumstances of a reading, accessibility applies to *particular readers in particular circumstances*. Accessibility is a much more useful concept than readability in the context of this study. All three components of Halliday's context of situation are necessary to adequately describe the accessibility of a text. Consequently, a combination of research methodologies was required.

Three levels of *circumstances of a reading* were identified. First, the *national context* which included Government policy and other decisions taken at a national level. Secondly, the *institutional environment* which included the institutional ethos, policies, culture and resource management. Thirdly, the *classroom context* which included the attitudes and competence of teachers and students and day to day decision making. One implication of these levels of circumstances of reading is that they present three levels of management of textbooks and their use at which recommendations arising from the findings of the study might be implemented. These levels of management are, *those producing textbooks, policy makers* and *teachers*.

The national context was described through studies of policy documents and interviews with relevant people. The institutional environment was described through studies of Ofsted reports, policy documents and school prospectuses and through interviews with members of staff. The institutional environment was considered to be the level responsible for the greatest diversity between groups of students and a *case studies* approach was adopted for dealing with these data. Separate *school profiles* were written for each of the schools which took part in the study. This was,

> "*an archive of descriptive material sufficiently rich to admit subsequent reinterpretation*" [Cohen & Manion 1989 p. 150],

which enabled the identification of differences between groups of students arising from differences in the extent of bilingualism in communities. An important aspect of the compilation of these profiles was the interviewing of the Head of Science in each school. This approach gave the Heads of Science an opportunity to participate actively in the study and to clarify important issues. The profiles were subsequently checked by the Heads of Science and, if necessary, amended. This was also an opportunity for the researcher to strike up a rapport with his main contact person in each school studied. Information concerning individual classroom contexts was collected through questionnaires and interviews. Questionnaires were collected from each student (n= 1520) and teacher (n= 36) in the classrooms studied (n= 79), one teacher in each school studied was interviewed (n= 16).

The first perspective on the accessibility of the Nuffield Co-ordinated Sciences Biology textbook, *student performance on tasks related to the textbook* could have studied through tasks involving comprehension, discussion, information recall, text rewriting , cloze procedures or through the analysis of examination results. Examinations do not emulate normal classroom contexts and involve no talk about the text in question. Examination results analysis was consequently rejected as a research methodology. Comprehension and information recall were rejected because they take insufficient account of the interpretative aspect of reading and understanding discussed in Chapter 2 (see 2.3) [see also Moy & Raleigh 1980]. The assessment of such tasks is likely to be subjective and susceptible to researcher bias. The assessment of rewriting tasks may also be subjective and susceptible to researcher bias. This might cause problems in this research study where it was intended to compare data collected from different groups of students. It was also important to offer students research tasks which differentiated between students on the basis of their understanding of the text rather than on their ability to write sentences in English. The analysis of rewriting tasks is time consuming and they were rejected as impractical in the present study which used a large sample. The discussion task is a useful idea. Subjects can create maps of their route through the content of a text and their conversation whilst attempting the task can be tape recorded and analysed. This technique was used to provide information about the textbook studied in use, as part of a pilot study. However, the technique was not used in the main research study because its administration and analysis were time consuming and the technique could not cope with the size of sample selected for this study. Extracts from the transcript made (Transcript 10201) are presented in Appendix B.

The sample of students selected (n= 1520) was made large enough to include sufficient bilingual students from the schools studied with more than 10% bilingual students to facilitate the statistical analysis of the data collected. The large sample also facilitated the investigation of gender differences. However, even this sample of 272 bilingual speakers of 59 languages was not big enough to enable comparisons to be made between speakers of different languages. There are ethical issues surrounding questioning students about their ethnic origins and about singling out students of particular ethnic origin. These issues were tackled by sampling whole year groups of students. The large size of the sample was also intended to reduce the risk of drawing attention to ethnic minority students, making them feel inhibited about responses.

A cloze procedure was adopted as an objective methodology with a long standing literature and comparable, standardised American scores. Bensoussan [1990 pp. 24-25] cites various authors to show that cloze procedures are effective measures of language proficiency with both native and non native speakers. Although criticised by some authors [see Bensoussan 1990 p. 25] a random cloze procedure was adopted. Random cloze procedures were preferred to modified rational, discourse and cohesion cloze procedures, because the selection of the words deleted does not depend on value judgements made by the researcher. Random cloze procedures test a wide range of text understanding skills. The data collected in this way can be analysed statistically and can be broken down into lexis, grammar and genre components. As Bailey and Harrison point out [1984 p. 186, Merzyn 1987], cloze tasks produce objective results based on students' interaction with text. These data can be analysed by computer. The volume of data produced by the sample selected for this study necessitated the use of computer data analysis.

The accessibility of the textbook studied from the second perspective, as *the judgements of teachers and students*, could have been studied through classroom observation, questionnaires, discussion tasks or interviews. Classroom observation [see Wragg 1994, Hopkins 1985] was discounted as an indirect method of assessing students' and teachers' attitudes and opinions which might be liable to observer bias. However, many classrooms were visited during the course of the study and the informal observations made contributed to insights and inferences drawn. Of these informal observations, a tape recording which was made of a fragment of a Nuffield Co-ordinated Sciences class in action using a biology textbook was transcribed. The lesson concerned was typical of those observed. The data are presented as Transcript 10111 in Appendix B. The transcript has been used as evidence to illustrate various points concerning teachers' and students' language throughout the thesis. Another indirect means of collecting information about students' attitudes and opinions involves tape recording students' conversation during discussion tasks based on the text (see Appendix B Transcript 10201). The possible disadvantages of this technique are mentioned above. However, a discussion task was used in this way and the data collected contributed to the pilot study.

Interviewing [Wragg 1978, McCracken 1988] is a direct means of collecting useful information about attitudes and opinions whereas questionnaires [Youngman 1978, Oppenheim 1992] are slightly less direct. Cohen and Manion [1989 p.308] compare the two techniques. Interview data may be more valid and consistent than questionnaire data because they are collected through interaction between the researcher and the subject that provides opportunities for clarification of meaning. However, interviews are more time consuming than questionnaires and involve more organisation in the host school and disruption of courses and teachers' planning. They involve a few students at a time, require a separate, quiet room and possibly may involve requests for parental approval. Interviews could not cope with the size of sample selected for this study. Questionnaires are a less direct means of collecting data. However, they are less time consuming, less disruptive and easier to organise within host schools. Questionnaires were used as a main research methodology within this study. However, they were administered in such a way that clarification of meaning was available and subjects were encouraged to record informal discussions with the researcher and his assistants. Tape recordings were also made of informal responses by research subjects. As questionnaire responses tend to be descriptive rather than explanations [Munn & Drever 1995 p. 5], some open-ended questions were included to enable respondents to write at length. In order to strengthen the inferences drawn from the questionnaire data, a small sample of students (n= 8) and teachers (n= 16) were interviewed formally. An analysis of the discussion task data collected during the pilot study revealed that the slightly impersonal nature of the questionnaire also helped to put some bilingual students more at ease than would be the case in a situation more like an interview. As McCracken [1988 p. 26] points out, a respondent's image of the interviewer can, "*dramatically influence*" how they respond to the questions asked. Cohen and Manion [1989] caution that,

"*The respondent may well feel uneasy and adopt avoidance tactics if the* *questioning is too deep*" Cohen & Manion [1989 p. 311].

The accessibility of the textbook studied could be investigated from the third perspective, *as a property of the textbook itself*, through readability formula analysis [e.g. Fry 1968, 1977], readability checklists [Armbruster & Anderson 1981, Irwin & Davis 1980, Singer 1985, 1986], lexical density analysis [Graddol 1992], grammatical analysis, syntactic complexity formula analysis or the analysis of grammatical transformations discussed Chapter 3 (see 3.5.3). These are all techniques which measure readability rather than accessibility and as such they are of limited value to this research. However, they might give a general impression of the textbook and as such could be used in combination with other techniques. Grammatical, syntactic complexity formula and grammatical transformations analysis were rejected as subjective, time consuming techniques producing data which might be difficult to interpret. However, grammatical analysis, and cohesion analysis were carried out on three sections of the textbook studied which were studied in detail and supported inferences drawn from other techniques. As Schumm and Mangrum [1991] point out, readability checklists involve the reader and thus measure accessibility. However, they were rejected on the grounds that they are subjective and would produce data which might be difficult to interpret. Lexical density and readability formula analysis are similar statistical techniques. They are objective, quick and easy to administer and could be used within this study to provide an overview of the textbook studied. A readability formula was used for this purpose. Unlike lexical density analysis, readability formula analysis as been related to students' achievements [Harrison 1980b] and the results are easier to interpret. Examinations of legibility, the accessibility of figures, genre and language, together with the data collected through the discussion task, put this general insight of the textbook studied into perspective. A detailed study was carried out on the extracts from the textbook which were used for the cloze task. The cloze task involved close interaction between the text itself and research subjects. As such it examines the accessibility of the textbook from this third perspective and was the main methodology used for this purpose.

4.4 Triangulation

The reliability and validity of data can be strengthened if similar data collected in different ways or from different sources is shown to agree. This process is called "*triangulation*" of data [Cohen & Manion 1989 pp. 269-286]. The use of triangulation reduces the effects of the bias which might be introduced into a study through over-reliance on one particular research method. Triangulation justifies a researcher's confidence in findings, particularly if contrasting research methods are used. The process of triangulation can also provide fresh insights on data sets.

There was some scope within this study for "*methodological triangulation*" [Cohen & Manion 1989 p. 272] between data sets, where similar information was collected from different sources using different methods. For instance, the data about institutional environments collected from documents were compared with those obtained from interviews and then checked by showing the profiles to school staff for further amendment. This procedure improves the reliability of the data. It was also possible to compare assessments of the readability of the textbook determined through readability formula analysis, questionnaire responses, grammatical analysis, interview responses and cloze task responses. The reliability of the school profiles was also checked through a limited amount of what Cohen and Manion [1989 pp. 274-275] call "*investigator triangulation*". Two developing school profiles were discussed (this exercise is described in Chapter 6: 6.3.2) with an experienced educationalist who was briefed with the aims of the project and assisted in data collection in both schools (1004 & 1039). She confirmed that the school profiles were unbiased accounts of each of these schools. Collecting data from a range of types of schools, which are well separated geographically facilitates "*Space triangulation*"[Cohen & Manion 1989 pp. 272-273].

4.5 Summary

This chapter acts as a link between the theoretical framework in the first part of the thesis and the detailed description of the study in the second part. Consideration of the research questions led to the development of a research agenda for the study. The study was outlined in terms of *context description*, *methodology*, *analysis*, and *implications*. Broadly speaking these topics comprise the themes of the next four chapters of the thesis.

Chapter 5: The exemplar textbook in context

5.1 Introduction

The work described and reported in this thesis included classroom research in secondary schools with students using the Nuffield Co-ordinated Sciences Biology textbook. This chapter includes a critique of the textbook and provides background information in support of the account of the research given in Chapters 6 & 7. The first part of the chapter describes the national environment of the textbook. The second part of the chapter is a discussion of pedagogical and linguistic aspects of the textbook. Short extracts from the textbook are included in this chapter in order to give the reader an idea of what the textbook is like.

5.2 The national environment

The Nuffield Foundation's interest in school science courses originated in the curriculum development movement of the sixties surrounding students' active learning through experimental investigation. This empiricist approach became the hallmark of Nuffield science courses. The courses were an important innovation at a time when practical work in science in many schools was limited in scope. However, the approach was later recognised as "*guided discovery*" rather than,

> " *"to awaken the spirit of investigation and to develop disciplined imaginative thinking" [Nuffield Foundation 1966]*" [Gott & Duggan 1995 pp. 18-19].

The development work grew in collaboration with Chelsea College during the seventies. The Nuffield Chelsea Curriculum Trust was formed and published materials through Longman. A lower secondary school combined science course, a secondary science course leading to CSE and separate biology, chemistry and physics courses preparing students for GCE O Level, were popular with staff and students. Advanced courses were later developed. During the late eighties the Trust responded to changes in the examinations system and Government calls for "*broad balanced science courses*" [DESWO 1985] with *Nuffield Co-ordinated Sciences* and *Pathways through Science*. In 1994 development activity subsided and the Trust was subsumed back into the Foundation.

The book studied was intended as resource material for the biological content of the Co-ordinated Sciences course. Coverage served the GCSE National Criteria for *The*

Sciences: Double Award [JCGCSE 1987] but does not match the National Curriculum for Science which was first described in 1988 [DESWO 1988]. Scientific topics are discussed through contexts, another feature of the Nuffield philosophy. It is a well illustrated book of about three hundred pages and was published in 1988. It was designed to be used in conjunction with published activities many of which originated in the course's predecessor, Nuffield Biology, an O Level course.

5.2.1 Influences on courses

The Nuffield Foundation arranges meetings of groups of teachers and other educational professionals interested in the course and its development. Twelve regional *user-groups* cover the whole country. They provide support for teachers using the course and disseminate information. They report regularly to a National Committee which co-ordinates their work. The National Committee and the Nuffield Foundation make representations on behalf of course users at a national level. This structure provides a mechanism for liaison between classroom practitioners and interested parties such as the Government, publishers, authors, exam boards, professional organisations and Universities. The National Committee for Nuffield Co-ordinated Sciences publishes termly newsletters about developments and organises INSET for teachers.

As Muther [1985 pp. 4-8] points out, publishers produce books as commercial enterprises, a factor which can cloud their judgement and affect educational decision making. For example, commercial constraints dictated that, even though Nuffield Co-ordinated Sciences has been successful, an edition in Welsh was only possible through Government grants [Pevsner 1992]. Innovation tends to be *reactive*, rather than *proactive*. Employers and other organisations have a, vocal, vested interest in science education. For instance, in 1987 sixteen such bodies endorsed Double Award Science [The Engineering Council/SSCR 1987].

Course choice depends on school micropolitics, availability of money and resources. It is unusual for students (in the author's opinion, the real customers) to be consulted. Resource management concerns include the willingness of staff to teach outside their science discipline and the suitability of rooms for certain kinds of practical work. As Fullan [1992, 1982 pp. 183-211] points out, the management of course choice and the implementation and sustentation of course change involves resisting inherent conservatism in working teams. Schools are dynamic institutions. Over time a Department may develop or regress to a point where further course change is necessary before it can be resourced. Recent HMI reports [1992 p. 21, Ofsted 1993a p. 19, 1995b p. 17] concluded that textbooks are not used as much as they might be in science classrooms due to inadequate resourcing. The 1995 Education Publishers' Council survey [Fisher 1995, Rosenthal 1996] revealed a lack of investment in textbooks in British schools compared with other European countries.

The move to co-ordinated sciences courses signalled a loss of autonomy and status for some teachers previously responsible for single subject science courses. Although this change was inevitable, the accompanying dissatisfaction and discontent is likely to be focused on the course. Those who made the original course selection decision may no longer be entrusted with its implementation. Consequently, arguments justifying the course may not be rehearsed. The course must be taught across the three disciplines and implies consensus between disciplines, which within institutional constraints, is often difficult to obtain.

5.2.2 Why Nuffield Co-ordinated?

In 1993 this course was one of 82 Double Award syllabuses offered by the examinations boards [Smithers & Robinson 1994 p. 14]. Many schools took up the course when the materials were published in 1988 and there was very little similar alternative material available. It offered some subject autonomy within a broad balanced framework and was attractive to Departments previously running separate sciences courses. Some teachers saw the course as an opportunity to comply with Government requirements with the minimum of change from existing practice. The course represents a considerable financial investment (in some cases supported by Technical and Vocational Educational Initiative grants) and some Departments continue with it through necessity rather than commitment (see Appendix A).

Various authors [e.g. Mann 1981, Woodward 1987, Kantor, Anderson & Armbruster 1983] have written on the criteria to adopt when choosing textbooks and several checklists exist for the evaluation of science materials, some of which focus on particular issues [e.g. Ditchfield 1987 p. 40 on multicultural criteria]. Most of these checklists encourage the consideration of text accessibility. Unfortunately, all too often decisions are taken more on political and pragmatic grounds than pedagogical ones. Several teachers interviewed regretted the low priority given to text accessibility when they had selected Nuffield Co-ordinated Sciences (Appendix A). The "*Nuffield approach*" using "*guided discovery learning*" still appeals to some teachers [Ofsted 1994d pp. 12-13, MEG 1994b, 1994c] and has a good reputation with parents, many of whom grew up with it. The reputation, experience of and familiarity with, previous Nuffield courses affected course choice in some instances (see Appendix A). The tiered system of assessment which was introduced by the Midland Examining Group (MEG) and the Nuffield Foundation for 1995 is attractive to some Science Departments. Since the National Curriculum has imposed conformity on syllabus content, the style of assessment and layout of syllabuses have become more important in course choice [MEG 1993a]. The network of user-groups and support from the Nuffield Foundation is attractive to teachers teaching outside their home discipline.

5.2.3 Nuffield Co-ordinated Sciences

Nuffield Co-ordinated Sciences was conceived as a course set to follow an agreed syllabus making the materials distinct from those designed to resource various syllabi (e.g. *Pathways through Science* [NCCT 1992-94]). The original materials comprised, the syllabus, textbooks and worksheets for each discipline and a Teacher's Guide [MEG 1993a, NCCT 1988a, 1988b, 1988c, 1988d, 1988e, 1988f, 1988g]. The biology textbook was the only material in full colour.

The examination syllabus for Nuffield Co-ordinated Sciences was administered by MEG and the course was first examined in 1990 when 9,595 candidates were entered for the examination. Each candidate was awarded two GCSE grades and there was a small element of continuous assessment. The number of candidates entered rose to 34,440 in 1991, 45,429 in 1992 and 45,823 in 1993. The entries compared with national sciences entries for these four years are shown in Table 5.1. In the five years since it had begun, the course had picked up a reasonable share of the market. It is a stated aim in the Teachers' Guide [NCCT 1988a p. 4] that the course should cater for the whole ability range with differentiation provided by different routes through the material.

Table 5.1: GCSE examination entries for Nuffield Co-ordinated Sciences 1990-1994

Year	Number of Candidates	Total no of Candidates	Candidates as % of Total
1990	19,190	324,152	6%
1991	68,880	523,260	13%
1992	90,858	572,327	16%
1993	91,646	593,887	15%

[MEG 1994a] (NB as Nuffield Co-ordinated Sciences is a Double Award course, the numbers of actual entries are twice the numbers of candidates entered).

The Nuffield Chelsea Curriculum Trust based this new course on their well established, highly successful, single subject science courses. It was a response to the call for a "*broad and balanced*" approach to science teaching contained in *Science 5-16: A statement of policy* [DESWO 1985] and the publication of GCSE National Criteria for *The Sciences: Double Award* [JCGCSE 1987, Turvey 1993]. Nuffield Co-ordinated Sciences was thus intended to lead to the award of the equivalent of two GCSE examination grades. However, a Single Award syllabus is now offered [MEG 1993a pp. 89-91]. Provisional entries for 1994 were 36,779 for the Double Award examination and 2,702 for the Single Award examination [MEG 1994a]. In 1990 split grades were awarded, however, the 1991 syllabus was modified to conform to SEAC's (the Schools Examinations and Assessment Council) The Sciences: Double Award Criteria, which insisted on the award of double identical grades [MEG 1994a].

As noted earlier, the Nuffield Co-ordinated Sciences course predated the National Curriculum for Science [DESWO 1988]. Later impressions of the first edition of the Teachers Guide [NCCT 1988a] (e.g. the 5th, 1990), include a preface covering National Curriculum issues. The second edition of the Teachers Guide contains a chapter [NCCT 1992a pp. 19-40] on the relationship between the course and the National Curriculum and information about assessing Attainment Target 1 using practical activities from the course [e.g. NCCT 1992a pp. 110 & 226]. The course and syllabus were modified for the first assessment of Key Stage Four in June 1994 [MEG 1994a]. The Single Award Syllabus fulfils the requirements of the Single Science model in the National Curriculum orders [MEG 1993a p. 88, DESWO 1991 pp. 32-40].

A review of the material was carried out in 1992 in order to ensure adequate coverage of the revised National Curriculum for Science [DESWO 1991]. Subsequently, the Teachers' Guide was revised and enlarged and a supplementary pack of activities was published [NCCT 1992a, 1992c]. A supplementary textbook covered new areas of content, mainly Earth Science [NCCT 1992b] and new editions of the main textbooks were produced, with Physics and Chemistry in full colour. Apart from minor corrections and revisions the basic written texts remained unchanged as explained earlier in section 5.4.2.

In 1993 single subject science syllabi were developed under the Nuffield Co-ordinated Sciences umbrella [e.g. MEG 1993b]. In Biology, the existing four National Curriculum strands were supplemented with two additional strands, v) *Economically important organisms* and vi) *Biology and the health of the world's population* [MEG 1993b]. Supplementary activities packs supported these initiatives [NCCT 1994a].

In 1994 work began on a complete restructuring of the programme of activities for Nuffield Co-ordinated Sciences to match the post Dearing National Curriculum [DFEWO 1995a]. During this exercise the Secretary of State for Education accepted SCAA's proposal for a reduction in the number of GCSE syllabi [Hofkins 1995a]. Consequently, SCAA decided that from the 1998 examination, MEG will be allowed to offer only one co-ordinated sciences syllabus. Nuffield Co-ordinated Sciences Double and Single Award courses will be offered as a separate "*interpretations*" of the MEG Co-ordinated Sciences Double and Single Award syllabi rather than as a separate syllabi [Hunt 1995, Barrett 1995, MEG 1995]. This has implications for assessment. Separate single subject syllabi will continue. The new programme of activities will service this syllabus interpretation. However, there are no plans to revise the textbooks.

5.2.4 A book designed by a committee

A large team of people is involved in the involved in the production of a textbook. Each member of such teams has personal aims, expectations, influences, priorities and prejudices. The Teachers' Guide [NCCT 1988a] lists ten contributors and advisors for the biology component of the scheme, three general editors, a consultative committee of twelve, two practical evaluators and a team of eleven people at the Trust, not to mention the publisher and his team at Longman. Reference to *the author* in this chapter implies reference to the whole team of people involved in producing the textbook. At any stage in the production of a textbook anything which takes up somebody's time, either through commission or repetition, costs money. It is difficult and expensive to introduce policy changes into such a system.

5.2.5 Producing the textbook

Various authors and subject editors worked on the Nuffield Co-ordinated Sciences Biology textbook. A group of three general editors was responsible for coordinating the textbooks and course materials. Artists produced line drawings to briefs drawn up by these editors. Picture researchers selected photographs using similar briefs. The text was set out by a designer. These efforts were drawn together by a publisher's editors at NCCT before the manuscript was submitted to the publisher, Longman in the manner described by Evans, Watson and Willows [1987 pp. 87-88]. It is unlikely that all the people involved were ever brought together to discuss policy or purpose. The Consultative Committee for the project had a loose *overall* policy brief and were responsible to the trustees of the Trust [Turvey 1993]. However, they would have had little influence on everyday editorial decisions. Their policy and philosophy is reflected in the Foreword and General Introduction in both editions of the Teachers Guide [NCCT 1988a prologue & pp. 2-14, 1992a prologue & pp. 2-14].

The size and geographical spread of the team involved in producing a textbook is a problem when developing and implementing coherent policy. All the material passes across the publisher's editor's desk but, by that stage, changes can be expensive to implement. Publishers' editors, illustrators, picture researchers and designers are less likely to be educational practitioners than authors and subject editors. Picture research is limited by the time and resources available. Commissioned photographs are more expensive, and take longer to get, than those obtained from picture libraries.

A check through the photographic acknowledgements in the book showed that the number of picture sources providing suitable images for use with multicultural audiences is limited.

5.2.6 General comment

Ofsted inspectors commented about the Nuffield Co-ordinated Sciences textbooks and course materials in their report on one of the schools participating in the research [Ofsted 1994a] (School 1028, Appendix A) where all students, across the full ability range, followed the course. The inspectors felt that the course materials were not accessible enough to "*lower achievers*" because these students do not possess the reading skills required by the textbooks [Ofsted 1994a p. 10]. There are places where the textbooks and worksheets "*are not differentiated to match students' abilities*" [Ofsted 1994a p. 16]. The materials,

> "*are not always fully accessible to students with limited reading capability*" [Ofsted 1994a p. 29].

These observations contributed to general comments that the school curriculum did not cater for low achievers at Key Stage Four and that the quality of learning declined between Key Stages Three and Four [Ofsted 1994a p. 11]. The Key Stage Four curriculum did,

> "*not provide the rigour nor the challenge students deserve as an entitlement*" and it did not "*adequately meet the needs of students unlikely to succeed at GCSE*" [Ofsted 1994a pp. 8, 25].

In science,

> "*Few students at Key Stage Four are reaching high levels of achievement in lessons and the GCSE results are poor*" [Ofsted 1994a p. 16].

The inspectors commented that students were underachieving in science particularly at Key Stage Four [Ofsted 1994a p. 8]. However, Ofsted's [1994d p. 15] *Review of Science and Mathematics in Schools* describes the development of Nuffield Co-ordinated Sciences as "*a case study of success*" in the drive to develop,

> "*courses which sought to meet the combined needs of those who would go on to advanced study and yet were accessible to all students.*" [Ofsted 1994d p. 15].

Perhaps this disagreement between Ofsted's policymakers and fieldworkers exposes the gulf between theory and practice, or between the educational establishment and real classroom situations. Maybe this apparent contradiction highlights the fact that any course is only as good as the teachers who deliver it or that each evaluator brings their own preferences and prejudices to any assessment of course materials.

Various comments about the course and textbooks were collected from teachers and students through formal and informal discussions and questionnaires and through meetings arranged by MEG and the Nuffield Foundation. The author has talked to course practitioners, writers, editors, general editors, steering group members, publishers and the Principle Subject Officer for MEG Sciences. Some of these observations are reported in the school profiles included as Appendix A. Dillon [1994 p. 1] has collated other similar comments in the *Nuffield Co-ordinated Sciences Newsletter*. The course is generally accepted to be intended for *more able* students although it claims to cater for National Curriculum levels 4-10. Some teachers are dissatisfied with the examination results of more able students following the course.

In general, in state comprehensive schools there is pressure from headteachers, governors and parents to change to other courses at which students might achieve better GCSE grades. School league tables are often blamed as a cause for this concern with competition between exam boards cited as a possible reason for differences in standards. SCAA are aware of these pressures and consequently introduced measures to maintain standards and monitor examination results in 1995 [Prestage 1995]. Teachers commonly complain about the high *reading age* and difficulty of the textbooks. Many admit using them infrequently with all students and very little with less able students. Others complain about the form of examination questions and the style of answers required. However, teachers in independent schools and state grammar schools are generally satisfied with their examination results and the course textbooks. They tend to make extensive use of the course textbooks. The common parlance (discussed in Chapter 3: 3.2.1) of the students in this second group of schools is closer to Standard English, the language of the textbooks, worksheets and examinations, than the common parlance of other students. It is difficult to work out whether the courses at which students appear to be more successful are *easier* or simply different.

Words like *modern*, *easier*, and *a decline in standards*, are used to describe the courses at which students appear to be more successful [School 1029, 21.03.94]. The author would argue that these courses attempt to interest and motivate students through relevant contexts, the application of concepts and short term assessment goals. Placing less emphasis on the language of science and precision in expression. He would suggest that these courses evolved from modular, integrated and combined CSE science courses. Words like *traditional*, *academic* and *a good preparation for A Level* are used to describe Nuffield Co-ordinated Sciences [e.g. School 1007 27.05.93]. Students are required to *co-ordinate* their knowledge from the three science disciplines, favouring students with good communication skills. The Nuffield Co-ordinated Sciences course evolved from single subject science O Level courses. Whether *traditional* means *old-fashioned* and *out of date* and whether *modern* means *relevant* and *up to date* depends on one's point of view. However, this author thinks that there is a case for saying that this course has a different emphasis from some of the others, rather than saying that it is harder. He thinks that Nuffield Co-ordinated Sciences may place heavier language demands on students than some other GCSE courses and textbooks. Some students are better equipped to cope with these language demands than others [discussion with teachers, School 1029 21.03.94].

The Nuffield Co-ordinated Sciences National Committee wrote to MEG, in October 1993 voicing some of these criticisms. In response, the Chief Executive of MEG, Dr. Ron McLone commissioned a comparability study [MEG 1994a]. The study compared performances by centre type and by subject pairs over the period 1991-93 and found that Nuffield Co-ordinated Sciences awarded slightly lower proportions of A grades and slightly higher proportions of cumulative A-C grades than were awarded for Double Science nationally [NCCT 1994c pp. 1-2]. MEG science syllabuses appear to be slightly easier than mathematics syllabuses and routinely more difficult than English syllabuses. There were *discrepancies* in the standard of "*equivalent*" MEG Double Award syllabuses in 1993. The Nuffield Co-ordinated Sciences course "*is not the most difficult MEG science syllabus*" and its relative standards have remained consistent from 1991-3. The move from split grades to double identical grades depressed the examination results for this course. However, this was a SEAC requirement which should have had an equal effect on all courses. Nuffield Co-ordinated Sciences is relatively harder at grade A but comparable at grade C. The impact of the new stricter national rules for administering modular schemes and Mandatory Code procedures [SCAA 1994] should reduce discrepancies between the difficulty of syllabuses [see Blackburne 1994 Hofkins 1995a].

The course is popular with schools which retain separate Physics, Chemistry and Biology Departments and is used mainly with brighter students (see Appendix A). Schools using the course tend to have traditional values like school uniform and formal relationships between students and staff (see Appendix A). The Nuffield User Schools database indicates that course is popular in independent schools and state grammar schools. Teachers using the course interviewed during the research valued the Nuffield reputation and Nuffield approach and looked upon the course as a good preparation for A Level. The textbooks are used for classwork and homework. Students answer questions about the text, and use it for background reading, reference, making notes and copying diagrams (Compare these approaches with the strategies for using the textbook discussed in Chapter 2: 2.5.1 -2.5.4).

5.3 Readability, text structure and study skills

Students' difficulties in reading textbooks are caused by the legibility of the text, the complexity of the grammar, the vocabulary used, the structure of the text and the extent to which the textbook fails to promote study skills. These factors contribute to the *readability* of the textbook. Readability is affected by interest and motivation [Gilliand 1972 pp. 21-27], the layout of the textbook, the conditions in which the reading takes place and the language competence and background of the reader [Nelson 1978 p. 622]. As Perera [1980 p. 151, 1982a p. 101, 1984 p. 276] and others [Nelson 1978 p. 620, The Bullock Report, DES 1975 p. 113] point out, most teachers would agree that matching individual students with appropriate texts is an important part of the teacher's role. It is not surprising, therefore, that teachers and publishers have looked for ways of determining the "*reading levels*" of individual texts. That is,

> "*the chronological age of a person who should be able to cope with the text*" [Harrison 1980b pp. 12-13].

However reading level scores provide only "*estimates of reading difficulty*" [Nelson 1978 p. 621].

Harrison and Gardner [1977 p. 101] discuss "*supported*" and "*unsupported*" texts. Text is supported when used as in English, read allowed and discussed. In science, text may be used in various unsupported ways in class, for homework and to cover teacher absence. Consequently, Harrison and Gardner [1977] suggest

> "*that the reading level of science text ought to be about two years less than that of supported texts*" [Harrison & Gardner 1977 p. 101].

Research studies from various countries [Daugs & Daugs 1974 p. 471, Spring 1975 p. 131, Dangerfield 1981] indicate that high school and upper secondary school students read below the reading level of their textbooks. However Harrison [1980b] suggests that,

> "*two years is approximately the jump in reading level which a highly motivated reader can make*" [Harrison 1980b p. 47]

and Newton [1993 p. 68] discusses the beneficial effect of cleverly written resources. Several authors [e.g. Harrison 1980b, Graham 1978, Johnson 1979, DES 1975, Lunzer & Gardner 1984] point out that the readability of a text becomes significant when motivation is low and that it is dependent on the circumstances of the reading.

5.3.1 Readability formula analysis

Readability formulae are methods of predicting the readability of texts mathematically by calculating reading levels from statistical features of text, such as the number of words per sentence and the length of words. Readability formulae are quick and easy to administer and they give results as reading levels which are easy to interpret (compared with psychological methods of evaluating text [e.g. Gagne & Bell 1981]). The formulae involving word and sentence length have the added advantage that they can be carried out by computer.

Perera [1980 pp. 152-154, 1982a pp. 101-112, 1984 pp. 275-276] rehearses several weaknesses of readability formulae and Stokes [1978] shows that the reading level predicted for a single book may vary by five grade levels. Cognitive psychologists [Miller & Kintsch 1980, Gagne & Bell 1981 p. 98] charge that readability formulae lack supporting theory. As Moon [1981 p. 39] points out, readability criteria consider the text in isolation from the reader, whereas current models of the reading process involve text and reader. In a list of particular problems in the use of readability formulae with science writings, Reid [1984 p. 164] points out that they make no distinction between the difficulties in the concepts conveyed by words. He also suggests that the repetition of long words such as *photosynthesis*, which increases the reading levels calculated by the formulae, may assist understanding and readability. Daugs and Daugs [1974 p. 473] mention that readability formulae ignore the "*uniqueness*" of the vocabulary of science. Reid, Briggs and Beveridge [1983 p. 334, 2.4] complain that readability formulae take no account of the pictures accompanying text. However, Perera [1980 p. 159, 1982a p. 112] and Stokes [1978 p. 31] acknowledge the value of readability formulae as tools in research, as long as their limitations are recognised.

Within this research, a readability formula provided an overview of the textbook studied, quickly and efficiently. *Textgrader 2* software [Mahoney & Wynn 1991] was used to analyse extracts of about 100 words in complete sentences. The computer produced seven measures of readability for each extract. Of these the Fry [1968, 1977] method was used because it works well over the range required [Harrison 1980b p. 115] and it allows the data to be screened. The manual method is graphical, text statistics are plotted against a standard curve, which was developed by plotting data from numerous standard passages of literary prose [Fry 1977 p. 243]. The computer prints out the graph co-ordinates, *the number of syllables per hundred words* and *the number of sentences per hundred words*. These co-ordinates can be plotted onto a copy of the graph. A deviation from the standard curve indicates that the data may be invalid. Computer generated data from 17 prose, 17 questions and 17 captions passages from the textbook were plotted. As far as was possible, a passage within each category was chosen from the same sections of the textbook studied (see Table 5.a in Appendix C). The prose and questions text passages generally plotted close to the standard curve (in each case only one item of data was discounted from the analysis). Only half the points plotted for captions (9) plotted close to the standard curve. It was concluded that this method of determining reading level is valid for use with prose and questions passages from the textbook studied.

A random sample of 30 prose passages were analysed to provide an objective assessment of the overall readability of the main prose text of the textbook studied (see Table 5.b in Appendix C). These passages were chosen using a table of random numbers [Chalmers & Parker 1986 Appendix III 96]. It was difficult to gather collections of questions about a single topic of enough words to analyse. Consequently, the questions passages analysed were 18 arbitrary selections (see Table 5.c in Appendix C). Passages involving code switches (code switches are discussed in section 3.2.2) and the passages used for the research study cloze task (Chapters 6 & 7 describe the administration of this task and the analysis of the data collected) were also analysed (see Table 5.c in Appendix C). Biology textbooks convey essential health information, which should be available to all readers. Twenty eight such *essential health education texts*, covering topics such as diet and sex education were analysed (see Table 5.d in Appendix C). Thirty *essential organisational texts* which were analysed included passages from the introduction and chapter review sections (see Table 5.e in Appendix C). Tables 5.c-5.e also include information concerning the classification of each passage using Davies and Green's [1984 pp. 89-132] taxonomy of school science texts.

5.3.2 Readability findings

The full data are presented as Tables 5.a-5.e in Appendix C. Tables 5.c-5.e also include information about the links between this analysis and the analysis of figures from the textbook studied reported in Chapter 5 (see 5.4-5.4.2). The sample included examples of all of the categories of school science text listed in Davies and Green's taxonomy [1984 pp. 89-132]. The reading levels for the randomly selected prose texts range from 11 to 16 with a mode between levels 14 and 15. This sample of prose texts from the textbook studied included texts falling into of Davies and Green's text categories except *instructional* text. The randomly selected prose texts falling within each category included texts of the full range of reading levels, except hypothesis/theory texts where the one text studied had a reading level of 16. This varied, randomly selected, sample of passages from the main prose text thus indicates a reading level of about the chronological ages of the students which the textbook studied is intended to cater for (Key Stage Four or ages 14-16). There was no evidence to show that particular categories of text within the main prose text were associated with high reading levels. However, an hypothesis/theory text and a mechanism text had reading levels of 16.

Only one item of questions data indicated a reading level above 13, with over half the data clustered between levels 11 and 13. The questions passages which were analysed generally have a reading level of at least one year below the chronological ages of the students for whom the textbook is intended. Two switches from everyday discourse in Standard English to the scientific register were accompanied by increases in reading level (page 138 12-13, page 140 9-14). A switch from scientific discourse in Standard English into scientific lexis also involved an increase in reading level (page 152, 12 to15, see also Chapter 6: 6.3.5, Table 6.3). Switches between discourses were not accompanied by reading level increases. The prose passages used later in this research as a cloze task (pages 61-62, 151-152 & 225-226) are typical of the prose passages found in the textbook as a whole in terms of reading level (reading levels range from 12 to 15). These passages include Davis and Green's [1984 pp. 89-132] *classification, process* and *structure/mechanism* texts and various code switches, one of which (page 152) was studied in detail and is discussed in section 6.3.5.

The reading levels of the prose samples amongst the essential texts ranged from 12 to 22 with a mode at about 15. These passages were just as, or more, demanding than the rest of the prose text. Fifteen out of 36 (42%) prose samples of essential text have reading levels above 15. The more difficult passages include some which could have been useful to students currently operating at reading levels below 15 in science lessons. Five of the 8 chapter review sections have reading levels above 16. Passages concerning sports injuries and the health risks involved in smoking have reading levels of 17. Two sex education passages have reading levels of 18 and 22.

5.3.3 Legibility and the use of colour

The textbook studied is set in 10 and 11 point type which is within the size range that Harrison [1980b p.16] recommends for 9-13 year olds. The textbook is printed in unjustified setting which, according to some researchers [Harrison 1980b p. 18] helps poor readers. Authors are divided on the use of italic script which appears in this textbook [Burnhill & Hartley 1975 p. 66, Harrison 1980b p. 27]. Johnson [1979 p. 563] recommends line lengths in the range 60-90 mm and Williams [1983 p. 119] favours a three column page arrangement. The lines of text in this textbook are up to 125 mm long in a single column. The type from the other surface shows through the paper and the silky surface is less good for reading than a non reflective matt surface

[Johnson 1979 p. 563, Gilliand 1972 pp. 37-38]. Although the authors [Turvey 1993] fought hard for the textbook to be printed in full colour, this is not an important factor in the scientific understanding of photographs [Reid 1990a p. 167 cited in Chapter 2: 2.3.7]. In the new edition, questions and headings printed on coloured backgrounds replace headings between ruled lines and questions on grey backgrounds, the sections of the textbook are colour-coded and symbols signifying the skills and processes required (see 5.3.4) are highlighted in colour.

5.3.4 Text organisation, patterns and purpose in reading

Questions at intervals in the textbook and on the complementary activity sheets may encourage the *short bursts* style of reading rather than *reading for learning skills* as discussed in Chapter 2 (see 2.3.2). Some of the students taking part in the study criticised the textbook for its lack of logical structure and for a lack of linkage between text and related figures (see Table 7.1 in Appendix E). Several of the teachers and students who took part in the study and who were using the old edition were unaware of the structure of the textbook. It is divided into sections each made up of several chapters. Davies and Green's [1984 pp. 103-121] *mechanism, process, concept-principled* and *hypothesis-theory* texts are generally dealt with in a causal way which, as explained in Chapter 2 (see 2.6), should help understanding. Their instruction, classification and structure texts, which make up a large part of the textbook, are not. The textbook does not include Advance Organisers or Perera's introductory statements (which were discussed in Chapter 2: 2.5.3) but it does make limited use of *commentary text* which is intended to guide the students through their study of the text [see Brown 1994 p. 7].

Commentary text is dispersed within the main text and is printed in smaller italic type. The Teachers' Guide [NCCT 1988a pp. 4-5] develops the commentary concept further suggesting that it should assist in differentiation. However, there is no guidance on how this could be achieved. The Teachers' Guide [NCCT 1988a p. 5] and the textbook [page 6] acknowledge different types of text with different functions within the textbook. Some indication of where these text types appear would have been useful. Special symbols in the left margin of the text are intended to direct students to use particular skills; *observation, measurement, interpretation, application* and *planning*.

5.3.5 The readability of this textbook

The main prose of the textbook studied has at a reading level of about the chronological age of students expected to use it (Key Stage Four or ages 14-16). For various reasons this reading level might be too high for many students. Various texts, regarded as essential to all students because they contain important health education information or because they help to organise the knowledge learnt, have even higher reading levels. However, the questions in the text are pitched at an acceptable reading level. It was also found that some code switches were accompanied by sudden increases in reading level. Legibility and the use of colour did not seem to pose any serious readability problems. The textbook was considered to be weak in terms of text structure and the encouragement of classroom practices which improve text accessibility.

5.4 Figures

Figures have an important role to play in the accessibility of textbooks. Chapter 2 (see 2.6.3) explains how figures may provide suitable contexts, define terms, locate structures and demonstrate the flow through a process. In the textbook studied, explicitness varies from photographs through diagrams and cartoons to line drawings. Cartoon-style drawings portraying European images are used sparingly in the textbook studied. The lack of cartoon style pictures is of limited importance to the textbook's accessibility, as explained in section Chapter 2 (see 2.4.3). Diagrams follow western scientific conventions which were described in section Chapters 2 and 3 (see 2.3.6, 3.4.1). There are also *water colour* style drawings. The page layout follows the conventions set out by Goldsmith [1984 p. 404, 2.4] and the textbook reflects the *recto linear form* discussed in Chapter 2 (see 2.6.3). The figures in the textbook were examined from a multicultural perspective to assess their contribution to accessibility for bilingual students.

5.4.1 A study of multicultural accessibility in figures

The analysis focused on the 102 (of 480) figures in the textbook including images of people. It was considered that these figures were relevant images about which it would be possible to make consistent judgements. Some use was made of Kress and van Leewen's [1990] "*grammar of graphic representation*", which is discussed in Chapter 2 (see 2.3.6), in this analysis. The taxonomy developed differed from others [e.g. Reid 1990a p. 163] due to the emphasis on factors affecting accessibility and multicultural situations. Both editions of the textbook were analysed. Information about the sources of photographs and differences between the editions was also collated.

The people depicted in images were divided into, white, non white and either (i.e. it was not possible to tell). The number and sex of the people shown was recorded (see Table 5.f in Appendix C). The purpose of an image was categorised as *instruction, exposition, creating a familiar context* and *illustration* (see Table 5.g in Appendix C). These categories relate to Levin, Anglin and Carney's [1987 pp. 53-63] functions of figures, instruction to "*organisation*", exposition to "*interpretation*" and creating a context and illustration to "*representation*". Levin et al's "*decoration*" and "*transformation*" functions were not found in these figures. The exposition and instruction categories relate to Duchastel's [Duchastel & Waller 1978 p. 21] "*explicative*" and "*retentional*". The *illustration* and *context creation* categories to his "*attentional*". Duchastel and Waller [1978 p. 21] point out that it is difficult to discuss the relative merits of these roles of illustrations as their value depends on the text being illustrated. They explain that instructional texts use a lot of explicative illustrations and quote scientific diagrams as "*prototypical*" of the use of diagrams to explain that which "*would be cumbersome to explain in purely verbal terms*" (this form of scientific diagram is discussed in Chapter 3, see 3.4.1 and 3.4.4). *Expositive* figures present information not contained in the written text but which is important to the argument. Fig 12.11 [page 152] (see Appendix D) is a diagram showing the kidneys and related organs in position in the body. It is expositive because it presents information not included in the written text about the spatial relationships between the kidneys and other parts of the body,

"*The position of these bean shaped organs is shown in figure 12.11*" [page 152].

Figure 12.11 is also illustrative because it illustrates parts of the written text,

"*only 1.5 litres will trickle down your ureters to be expelled from your bladder when you urinate*" [page 152].

Figure 12.12 [page 153] is purely illustrative, it shows a person on a dialysis machine which is also described in the text.

Some figures help to create a context for the reader in which they can perhaps better understand the information contained in the text. For example, the drawing of Robert Foster holding his breath underwater [Figure 7.1 page 75]. References to figures in questions in the text or activities from the worksheets were noted. The images were also examined to see if the people depicted were doing anything and whether they were positive or negative images (see Table 5.h in Appendix C). If one asks the question 'Is that person in a desirable situation?' it is easy to judge that figure 6.7 [page 68],

> "*A starving child may look swollen because fluid is retained in the tissues*"[page 68],

is a negative image. The style of presentation of each figure (i.e. diagram, sketch line drawing or photograph; in black and white or in colour) was also noted (see Table 5.h in Appendix C). The differences in the figures between the two editions of the textbook were recorded in Table 5.i in Appendix C.

5.4.2 Figure accessibility findings

The full data discussed in this section are presented as Tables 5.f-5.i in Appendix C. Tables 5.c-5.e include information about the links between this analysis and the analysis of reading levels of extracts of written text from the textbook studied reported earlier in this chapter (see 5.3.1-5.3.2). There is only one figure in the 1988 edition [page 7] of the textbook studied which depicts both white and non white people. This represents 1% of the figures with images of people and less than 0.25% of all figures. Three figures include images of white people with others who were not discernable. Sixty seven figures include images of white people, seven include images of non white people. Thirty two figures include images of people who could be either white or non white, of which nineteen were diagrams and drawings. The fifteen figures which portray negative images, include five of the seven (71%) images of non white people compared with nine of the sixty seven (13%) images of white people. The twenty one figures which do not create a context, include six of the seven (86%) images of non white people and twelve of the sixty seven (18%) images of white people. Figures linked with instructions, activities and questions included four of the seven (57%) images of non white people, twenty six of the sixty seven (39%) images of white people and fifteen of the thirty two (47%) images which could be either.

Two figures in the 1992 edition [page 7 & Figure 23.8 page 303] include images of both white and non white people and two others include images of white people with others who are not discernable. Fifty eight figures include images of white people, sixteen non white and thirty two which could be either. There are seventeen changes between the 1992 and 1988 editions, twelve of which affect figures studied. The photograph of the Nobel medal [Figure 5 page 2] is changed from monochrome to colour. Figure 6.7 [page 68] is changed from a photograph of a starving African to one showing a starving European. Figure 20.16 [page 263], which shows a contraceptive cap is expanded to include a picture of a Chinese family planning poster. The other nine are changes from images of white people to images of non white people, all of which create context and none of which involve negative images. It was discovered that these images had been obtained from a limited number of sources (see the Acknowledgements in the second edition of the textbook studied).

Only one of the changes to figures [Figure 6.7 page 68] involves an image classified as negative. The sixteen figures which portray negative images include four of the sixteen (25%) images of non white people and ten of the 58 (17%) images of white people. The twenty one figures which do not create a context, include five of the sixteen (31%) images of non white people and thirteen of the fifty eight (22%) images of white people. Figures linked with instructions, activities and questions include eight of the sixteen (50%) images of non white people, twenty two of the fifty eight (38%) images of white people and fifteen of the thirty two (47%) images which could be either.

The seven figures including images of non white people in the 1988 edition are over represented in the lists of negative images and the figures not linked to creating context. In general the non white people, as depicted in these figures, are not doing anything. Whereas forty three of the figures show active people, only two of these show non white people, figure 3 the scientist, [page 1] and figure 23.13 the Burmese woman weaving [page 305]. Non white people could have been shown injecting themselves with insulin [Figure 12.9 page 150], being born [Figure 20.14 page 260], or eating [Figure 6.6 page 67]. In some cases the negative image portrayed in the figure is reinforced by the text. For instance Figure 13.1a [page 156],

"*Masai women and children in front of their huts in the Rift valley in Kenya*",

is reinforced with,

"*Humans are unusual because, unlike most other living organisms we are able to control the environment we live in. We have not always done this- for example our early ancestors did not make clothes or build houses. They stayed in their natural environment, which was probably tropical grasslands in Africa (see also Chapter B23).*" [page 156].

Some of the questions linked with figures depicting non white people could be interpreted as pejorative, for example,

"*Pests are not the only things that prevent us from providing enough food for people to eat. Give two other reasons why some people (see figure 17.5) are still short of food the whole time?*" [page 209],

"*These Ethiopians are among the many people who still suffer from famine*" [page 209],

and

"*Burmese babies are never born with long necks. How do their mothers (figure 23.14) get their long necks?*" [page 305].

"*Prevent us from providing enough food*", "*are still short of food the whole time*" and "*who still suffer from famine*" suggests dependency, incompetence and a lack of self sufficiency. The third question does not portray a positive image of any Burmese people. Captions like "*Masai women and children in front of their huts*" [Figure 13.1 page 156] could also be considered to be insensitive.

These observations are part of a pattern. Generally in the old edition of this textbook, images of non white people illustrate points in the text, they arise when they are being studied by the reader. They are *content* not *context*. They are not intended to be part of a context created by the reader, or assumed by them to be familiar. Two images are positive, a scientist [Figure 3 page 1] and the mixed group of school students [page 7]. The standpoint of the text is white Anglo Saxon [Turvey 1993]. The book adheres to the publisher's maxim that about 10% of photographs should show non white people [Pevsner 1993]. However, in the author's opinion, the functions performed, and the images portrayed, by individual figures has not been considered carefully enough.

The new edition has a redesigned cover but the written text and page contents are much the same as the old edition enabling the editions to be used together in the same classroom. Some changes to the text [pages 266-267] reflect changes in the perception of AIDS between 1988 and 1992. Other minor changes [e.g. Figure 2 page 5] make the figures involved clearer. A few of the questions have been reworded, either to make the meaning clearer or to correct errors [e.g. question 15 page 41]. The bulk of the changes are concerned with multicultural matters. However, all but one of the negative images involving non white people and all the questions and captions queried above are intact. There is still a higher proportion of images of non white people than those of white people which are negative, and which do not create a context.

Ideally, textbooks should contain images of non white and white people together. It is, however, pleasing to see that about a third of the figures studied were images of people, of no particular colour. These images should contribute to the reader's self creation of meaning and context in a receptive reading of the text as described in Chapter 2 (see 2.6, 2.6.3), regardless of their background. Questions, activities and instructions are important to classroom management and learning. It is good to see that out of forty one figures which are linked to questions, activities and instructions, a third (37%) involved figures where the person depicted could be either white or non white. A survey of the picture library sources used confirmed that there are only a few sources of multicultural material.

5.5 Interpretation, reader's position and genre

Much of the textbook is written from an *expert's* perspective. It invites the reader to absorb information without question referring selectively to the student's assumed prior knowledge. Some of these assumptions are culturally based and take insufficient account of personal thoughts or recollections provoked, including insights gained from other sections of the textbook. This is what Torbe and Medway [1981] criticise as the "*tone of voice*" of textbooks. Readers are assumed to have studied the topics in the order presented. However, evidence was collected from interviews with teachers (see Appendix A) to show that the order of topics varied a great deal.

Contrived "*contexts of culture*" (see Chapter 2: 2.6.4) [Halliday & Hasan 1989 pp. 6-7] may have important multicultural implications. The context of much of the writing and figures, and the reader's position of the textbook studied (see Chapter 2: 2.6.2) appears to be white British middle class (see 5.4.2). The material is presented as *science in context* rather than *the appliance of science* (see topic presentation in the syllabus [MEG 1993a]). The textbook mentions eleven scientists by name, all are white Europeans including just one woman. The figures analysis concluded that images of males outnumbered those of females. In this author's view, the textbook does not include sufficient role models and encouragement for girls.

Definitions are not set apart typographically as discussed in Chapter 3 (see 3.3.3). They are dispersed throughout a passage, rather than occurring near the beginning as suggested in Chapter 3 (see 3.6.1). Brackets, inverted commas and italics are used in a haphazard way for other functions as well as definitions. The index contains no references to some important words and concepts (see Chapter 3: 3.3.4) and to the companion textbooks. There is no glossary (see Chapter 3: 3.3.3). Many technical terms are used without explanation. As the learning process includes the continual redefinition of concepts and refining of ideas there is a case for restating definitions of concepts which have been studied previously and grasped at previous levels of understanding. This would map out for students the examination requirements of this course.

5.5.1 Genre analysis and writing style

One method of genre analysis, which is advocated by Swales [1981, e.g. 1990 p. 140] and also by Nwogu [1991] involves dividing texts into chunks by shifts in emphasis which Swales calls "*moves*". The Nuffield Co-ordinated Sciences Biology textbook is divided into sections which follow a typical structure illustrated by the extracts used for the cloze task administered during the research study (the cloze task is described Chapter 6: 6.3.3-6.3.8, see also Appendix D).

1. Most sections are introduced with everyday background information, often including an illustrative figure.

2. The second part comprises subject based background information including references to other sections of the book. The move may be signalled by a language code switch.

3. The next part concerns new content including definitions, content figures and propositions.

4. The closing part answers propositions. It also summarises and poses further questions to be answered.

Teaching discourse messages occur throughout sections 2-4. The writing style of this book often employs a *role borrowing* strategy in part 1. The author moves to a much more authoritarian, impersonal style of writing in parts 2-4. Certain words and phrases such as *essential* and *in fact* are characteristic of the writing style.

5.5.2 Switches in the style of interpretation

The educational value in variation of linguistic codes was explained in Chapter 3 (see 3.2.2). However, as explained in Chapters 2 and 3 (see 2.6.2 and 3.7.2), switching codes in mid sentence or mid paragraph may create difficulties in interpretation for the reader. This is an extract from the textbook studied.

> *"A man was lying face down on the floor of a church eating a banana. When asked what he thought he was doing he replied "Eating a banana?". "What are you doing lying on the floor then?" asked the priest. "It's the only way I can catch it" said the man. He was suffering from the severely damaging disease syphilis (see page 266). In his case, the bacteria causing the disease had affected the cerebellum."* [page 140].

The extract, which was taken from a section about the brain, includes a code switch from Standard English into the science register. Superficially it is an account of a conversation. To make sense of the paragraph the reader needs to recognise the code switch between two sentences and the change in interpretation required. The extract illustrates the difficulty a reader might have in understanding the textbook if they were unable to recognise switches between language codes.

Students' and teachers' talk switches from scientific discourse into everyday talk and gossip and back again (e.g. Appendix B Transcript 10111 lines 079-122). This author has observed such switches in public lectures. Perhaps these switches are a common feature of all discourses [Blackburne 1995a, SCAA 1995]. However, subtle switches between unfamiliar codes in written text, with none of the clues such as body language, intonation and pauses available in spoken text, as in the teacher's use of *role borrowing* discussed in Chapter 3 (see 3.2.1), are likely to cause difficulties for some students. These genre and style features of text operate at a whole-text level [see also NCC 1989 p. A10]. It helps readers if writers avoid switching codes in mid paragraph or if they indicate it in some way. The anecdote above could have been presented as a speech bubble with the scientific discourse as a medical report.

5.5.3 Teaching discourse in the text

The textbook studied includes teaching discourse directed at the reader and echoes the I-R-F structure of teaching discourse discussed in Chapter 3 (see 3.3.2). For example,

> "*Where do we find greenness? You can see that it is not everywhere in the cells of the leaf but only in the rounded structures which are called chloroplasts. If a leaf is ground up in a liquid such as propanone (water won't do - why not?) a solution of the green colour is formed.*" [page 32].

This impersonal discourse which uses closed questions leaves little scope for alternative solutions, whereas in classroom I-R-F the feedback is adjusted to suit particular responses. However the authoritative stance is structured and predictable and may be the familiar pattern of normal classroom discourse.

Giving instructions and recipes is another function of teaching discourse in science lessons. This information, which is essential for active learning, is what Edwards and Mercer [1987 p. 95-98, see Chapter 3: 3.3.2] call "*procedural knowledge*". Most of the instructions and recipes required for practical work in the course are included on worksheets. However, there are some examples in the textbook,

> "*Breathe in and out of the apparatus through the mouthpiece until you notice a difference between the liquids in the tubes. You can use either lime water or hydrogen carbonate indicator in the tubes.*" [pages 76-77].

As explained in Chapter 3 (see 3.2.6), references to activities should improve the accessibility of the scientific language. References to companion textbooks facilitate *co-ordination*, a stated aim of the course. Teaching discourse is closely linked with the structure of the textbook, its layout, study skills and commentary text (see Chapter 2: 2.5.2, Chapter 3: 3.3.2 and Chapter 5: 5.3.4). Switching into teaching discourse in Standard English (sometimes using scientific lexis as the object of the discourse) *and quickly back* is a feature of the textbook studied discussed earlier (see 5.3.2) and in Chapter 6 (see 6.3.5).

The author also employs other teachers' tactics. For example,

> "*If teeth are so strong, how is it that dentists manage to stay in business?*
> *One reason is that although tooth enamel is very hard it can be "eaten away" by acid. If you feel your teeth with the tip of your tongue just before brushing them, they may seem slightly rough and sticky in places. What you feel is a substance called plaque which collects, especially between the teeth and around the edges of the gums (figure 4.10).*" [page 46].

Using Stubbs' taxonomy [1983 pp. 50-57] described in Chapter 3 (see 3.3.2), the first sentence functions to "*attract attention*". The question serves to limit the reader's thoughts to a "*specific topic*", it is the written equivalent of "*controlling the amount of speech*". The last section starting with "*If you feel...*" serves to "*check or confirm understanding*", "*summarise*", "*define*" and "*correct*". The student's responses have already been "*edited*" through the device "*One reason is.....*". The questions dispersed throughout the text, on shaded backgrounds (see Chapter 2: 2.3.7, 2.5.4), play an important role in "*checking or confirming understanding*", "*summarising*", "*defining*", "*editing*", and "*correcting*". This function is either performed by the textbook itself (as above) or left for elaboration by the teacher in the classroom.

The textbook controls through direct teaching discourse, or indirectly controls the classroom teaching discourse through strategically placed questions and the commentary provided by the Teachers' Guide. Teaching discourse is also used extensively in the complementary worksheets. This use of teaching discourse limits the teaching and learning situations where the textbook is appropriate and accessible. It may be that lessons not involving this textbook are conducted in a similar fashion (this may be what makes the book attractive to teachers who choose to use it).

5.5.4 The science register and this textbook

School science textbooks introduce students to the science register, they have a *language model* function discussed in Chapter 2 (see 2.5.1). However, the science register has features which may make text less accessible to readers. Consequently, the use of the science register in textbooks should be carefully considered. This extract includes impersonal features such as the generic definite article and agentless passive voice discussed in Chapter 3 (see 3.4.2, 3.5.1, 3.5.3).

> "*Undigested and unabsorbed food leaving the small intestine is called faeces. The faeces enter the large intestine where most of the water is reabsorbed into the blood during its passage along the intestine and what remains (now semi solid) leaves the body.*" [page 59].

It means:

"*Scientists call the undigested and unabsorbed food leaving your small intestine, "faeces". The faeces enter your large intestine. Your large intestine reabsorbs most of the water into your blood. What remains, which is now semi solid, leaves your body.*".

Combining the science register use of *the* with the Standard English use of both the definite and indefinite articles, produces sentences which appeared to cause students involved in the study problems [School 1021 21.04.95].

"At the top of the picture you see the smallest mammal in the world, the pygmy shrew, in relation to a horse's hoof. At the bottom, you see the largest animal, the blue whale in comparison with a horse." [caption to figure 10.19 page 123],

This could be rewritten as:

"Mammal species vary a great deal in size from the smallest, pygmy shrews, to the largest, blue whales. This picture shows a pygmy shrew next a horse's foot and then shows the size of the same horse next to a blue whale".

Impersonal discourse could be dropped from descriptive passages in science textbooks without harming the scientific argument of larger bodies of text. The faeces extract introduces a text headed "*The waste pipe*", all of which is descriptive and none of which needs to be impersonal. The caption to figure 10.19 supports a truly scientific argument about adaptation. As discussed in Chapter 3 (see 3.5.6, 3.7.3), descriptive supporting texts such as this need not be impersonal. However, the impersonal nature of the main text may be necessary in this case.

Scientific illustration is an important part of scientific discourse. It was argued in Chapter 3 (see 3.4.1) that particular rules and conventions apply to scientific illustration which make it part of the science register. The disembedded nature of such diagrams serves to focus attention and act as organisational aids to the reader's thinking (see Chapter 3: 3.4.4). Such diagrams are an accepted feature of biological textbooks and appear in the textbook studied.

Figure 5.4 [page 54, see Appendix C] is a diagram showing molecules passing through a membrane. It shows two sizes of green balls and a thick brown line with two gaps in it. The first sentence on this topic claims that,

"If you look at figure 5.4 you can see that if food is to be of any use to you it has to pass through the gut wall from the gut cavity into your bloodstream." [page 54].

Such images may place demands on readers. The reader may not understand the written text without accepting the author's interpretation of this highly disembedded, stylised drawing.

The following examples from the textbook studied illustrate grammatical features of scientific text which may cause students problems that were outlined in Chapter 3 (see 3.5-3.5.5).

> "*Your observations* ***should enable you to appreciate that*** *larger animals have legs which are shorter and thicker than you would expect if they stayed* ***in proportion to*** *body mass.* ***It appears*** *that long, thin legs are not* ***as effective as*** *short, stout ones for supporting large masses.*" [page 116].

The extract means,

You have probably noticed that heavy animals have short stout legs.

This example is taken from page 162,

> "*You* ***have*** *probably seen mustard seedlings growing in plastic boxes in greengrocers' shops and supermarkets. You* ***will*** *notice that they* ***are*** *crowded together and* ***are*** *easily cut for salads. Figure 13.10a* ***shows*** *what happens to the same plants if the seeds* ***are*** *sown in soil and left to grow for a week. Ten seeds* ***were*** *grown in one seed tray, one thousand in another.*" [page 162].

The caption to Figure 13.10 [page 163] includes "*were sown*", "*were photographed*", "*photographs..... show*" and "*is from the tray*".

The example could be written as,

"*The mustard seedlings you sometimes see growing in plastic boxes in shops and supermarkets are crowded and easily cut for salads. Figure 13.10a shows one week old plants, ten plants in one seed tray, a thousand in the other. You can see the effects of overcrowding.*"

5.6 Summary

The critique of the exemplar textbook in this chapter has included an overview of the national context and institutional environment. The main features of the textbook were described through readability analysis, figures analysis and examples drawn from the text. At the time of the research, the Nuffield Co-ordinated Sciences course was, with a fifteen percent market share, one of the more popular Key Stage Four courses in use. The textbook studied shares many features with other school science textbooks such as the *tone of voice of textbooks*. However, other features such as the *commentary* are unique. Together with various textbooks (e.g. Salters' Science Project textbooks) the Nuffield Co-ordinated Sciences Biology textbook does not service the latest version of the National Curriculum. It was concluded that it would be more accurate to describe this textbook as an *example of a school science textbook* rather than as a *typical school science textbook.*

Issues concerning readability and the environmental factors which contribute to the accessibility of the textbook have been considered. Readability is a general measure applied to texts. Whether it should imply "*functional literacy*" [DES 1975 p. 10] or "*complete comprehension*" [Harrison 1980b p. 43] is debatable. Accessibility applies to a particular reader, reading particular material, in particular circumstances. Reading descriptions such as *independent*, *instructional* and *frustration* for specific students in specific circumstances is one way of describing this concept. Environmental and cultural factors have an important impact on accessibility. The readability formula analysis described a textbook of varied difficulty. This led to a discussion of factors which may affect the readability of the textbook studied such as, legibility, the use of colour, text organisation, study skills, figures, layout, content context and the science register. The analysis of the data collected in the study that is discussed in Chapter 7 addressed these issues.

Chapter 6: Research methods

6.1 Introduction

The research agenda for the study set out in Chapter 4 (see 4.2) involved taking account of institutional environments, considering classroom contexts and investigating the language accessibility of school science textbooks, with particular reference to bilingual students. This agenda arose from two research questions. The first research question concerned whether monolingual and bilingual students have the same problems with school science textbooks. The second research question concerned whether bilingualism is an advantage or a disadvantage to students dealing with school science textbooks. The selection of appropriate research methodologies was considered in Chapter 4 (see 4.3). The use of a large sample of students, in order to include sufficient bilingual students to facilitate statistical analysis of the data collected and for ethical reasons, restricted the choice of research methodologies. The research methodologies chosen were questionnaires, interviews, a cloze task and a discussion task. Due to time constraints and limits on the availability of students, the discussion task was only used as part of the pilot study. For similar reasons, the use of interviews with students was limited. However, the data collected through student interviews provided valuable evidence in support of inferences drawn from the analysis of the data collected through student questionnaires and the cloze task. The use of several research methodologies facilitated triangulation between data sets as described in Chapter 4 (see 4.4). The textbook used as the subject of the empirical research, the Nuffield Co-ordinated Sciences Biology textbook was discussed in Chapter 5. The empirical research described in this chapter consisted of three main elements, *the selection of a suitable sample of students, the development of suitable research instruments and procedures* and *the gathering of data*. The chapter is in two parts, the first part (sections 6.2-6.2.9) is an account of the empirical research and the second part (sections 6.3-6.3.9) describes the research methodologies used.

6.2 An account of the study

From the outset in 1992, the research benefitted from the support of the Nuffield Chelsea Curriculum Trust (NCCT) and later from the Nuffield Foundation (NF). An initial enquiry concerning the numbers of bilingual students in schools and teachers' willingness to take part in the research was sent to all the schools using the Nuffield Co-ordinated Sciences course which were listed on a database held by the Nuffield Chelsea Curriculum Trust . Schools were selected to take part in the study from those which responded positively to this approach. Three groups of schools were identified. There were two groups of schools which catered for students of all abilities. In the first group, all the students used the Nuffield Co-ordinated Sciences course and the textbook studied. In the second group certain selected classes of students used the Nuffield Co-ordinated Sciences course and the textbook studied. These classes were selected through examination performance and teacher recommendation. The third group of schools were schools such as grammar schools which operated a selective entry policy based on examination performance but where all students used the Nuffield Co-ordinated Sciences course and the textbook studied. The sample of schools selected included representatives from each of these groups of schools where more than 10% of the students using the textbook were bilingual and others from each of the groups where less than 10% of the students using the textbook were bilingual. The sample was also representative of the schools listed in the NCCT database in terms of their geographical spread and other minor considerations. Five schools were visited in the Summer of 1993 as a pilot study. This work was followed up with main studies in the pilot schools during the Summer of 1994 when visits were also made to a further ten schools. The main studies were completed in Summer 1995 giving full data sets from twelve varied schools.

6.2.1 The initial enquiry

As noted in Chapter 4, an initial enquiry was sent out to all 500 schools listed on the NCCT database. The enquiry formed part of a questionnaire included in the NCS Newsletter dated 4th December 1992 . The three questions asked (see Figure 6.1 in section 6.3.1) concerned the proportion of bilingual students in Nuffield Co-ordinated Sciences classes, whether this was typical of Key Stage Four groups throughout the curriculum and lastly, whether the teachers concerned were interested in taking part in the research. The aim was to find schools which were willing to participate in the research, including some which had significant numbers of bilingual students. This method of finding a sample was preferred to writing to schools at random. It was assumed that volunteers would be more likely to prove reliable and be willing to co-operate with the study. The questionnaire also identified a contact person in each school.

Teachers in 57 schools replied, of which those in 35 schools were willing to participate. An early finding from the 57 schools which responded was that all reported that the proportion of bilingual students in Nuffield Co-ordinated Sciences classes was typical for Key Stage Four classes throughout the curriculum. Respondent schools were each allocated an arbitrary number and the returned questionnaire forms were stored for future reference. Taking account of practical considerations such as ease of access, five schools were selected for the pilot study. For broad, representative, coverage, four of these schools were state comprehensives and one was an independent school. Of the state schools, one was from a London Borough, one from a Metropolitan Authority area and two from County Council areas. These five schools included representatives of the three groups listed above and were widely spread geographically being located in London, Buckinghamshire, Cambridgeshire and Walsall. In three of these schools, an independent grammar school and two local authority comprehensive schools, more than 10% of the students who took part were bilingual. The Headteachers and the Heads of Science of these schools were contacted by letter. Nuffield headed notepaper was made available to the author for these crucial letters and, in his opinion, the credibility that this gave the study accounted for the subsequent interest in the research shown by teachers.

6.2.2 The pilot study

The five pilot study schools were each visited for half a day by the author. The research and opportunities for in-service training were explained and information about the school and Science Department was collected. Where possible, lessons involving students who might participate in the research were observed. These visits were used to establish a personal rapport with departmental staff. It was made clear that the relationship between the researcher and staff was a partnership. The teachers concerned were a source of information for the research and in most cases helped to administer the research tasks. These were key roles in the reliability and validity of the data collection. The researcher was well aware that mutual respect was important to ensure the continuing support and enthusiasm of colleagues which was vital to the validity and reliability of the research findings. It was also stressed that if a school pulled out of the study at any point, any information collected would still be useful (data collection was organised with this principle in mind). The researcher did not want to put colleagues under pressure to complete the research on the basis that data collected under such pressure might be invalid or unreliable.

Members of staff were interviewed using structured interview schedules (copies of the interview schedules used are included in Appendix A) to ensure sufficient coverage of policies, resource provision and other matters. These interviews were taped. Copies of key documents such as school prospectuses and policy statements were collected. Copies of Ofsted inspection reports were obtained, if available. The tapes and documents were used to compile a *case study profile* for each school (see Appendix A, 6.3.2). The tapes and documents were stored for the duration of the study for reference purposes. During subsequent visits, school staff checked the factual accuracy of the profiles and provided comments and suggestions for clarification, addition or deletion. All such amendments were incorporated into the profiles which were updated and expanded as and when this was appropriate. Class lists of groups of students taking part in the study were collected and teachers were given copies of the teachers' questionnaire (see Appendix D, 6.3.1) to fill in before the subsequent visit.

In each school, one class of Year 10 students, selected by the Head of Science, attempted the cloze task and students' questionnaire (see Appendix D). Their teachers filled in teachers' questionnaires. An additional study was carried out at School 1020 (this was the only pilot study school which was co-educational, a comprehensive, and had a large proportion of bilingual students). The teacher responsible for Nuffield Co-ordinated Sciences was asked to select a single sex group of four students, including some who were bilingual, but without any dominant members. These students had previously completed the students' questionnaire and cloze task in a class situation. They attempted a discussion task based on an extract about conservation from the textbook studied which was also used as part of the cloze task (see Appendix D, 6.3.8). The students' discussions, as they attempted the task, were taped and a transcript was made (Transcript 10201 Appendix B comprises excerpts from this transcript). Other materials which they produced during the task were collected as data. The tapes, transcript and materials were stored for the duration of the study for reference purposes. A short fragment of a lesson observed at School 1011 involving the use of a textbook was also taped and transcribed as part of the pilot study (see Transcript 10111 Appendix B).

The students involved in the pilot study were interviewed informally as they attempted the research tasks. They provided comments about the tasks themselves and the instructions given, together with some insights into the course and textbook studied. There was general agreement that the students' questionnaire used gave students sufficient opportunities to express any opinions which they had about the textbook. Students were encouraged to put any verbal comments about the textbook down in writing in their students' questionnaires and the researcher was able to use the pilot study to develop strategies to ensure that this was done in the main study. The comments about the textbook and extracts collected in this way contributed to the final form and presentation of the cloze task and questionnaires used with students.

During the initial phase of the research three versions of the discussion task, based on the three extracts from the textbook used for the cloze task, were attempted by a group of twenty PGCE students at the Institute of Education London University, by two groups of twenty B Ed students at De Montfort University, by a group of six teachers during an INSET session led by the author at one of the study schools and by a group of four sixth form students at one of the study schools. The materials developed for the task were also discussed at a seminar attended by research students at the Institute of Education. These sessions, which were recorded as taped discussions and written charts, provided valuable feedback about the textbook in general, about the extracts used for the cloze task in particular and about the tasks themselves. This additional feedback provided useful insights into the thoughts and attitudes of both teachers and students when this textbook is used in the classroom. The additional feedback contributed to the final form and presentation of the cloze task and questionnaires used with students and also to the form of analysis used with the data collected from students.

6.2.3 Administration

The students' questionnaire and cloze task were administered to students in their usual classrooms or laboratories. The researcher made up a *research kit* with all the necessary materials in it for each visit. This kit was checked against a kit list (see Appendix D) in preparation for each research visit and consumable items were replaced. The kit included a procedure and a protocol (see Appendix D). The procedure was an aide-memoire, listing the people to be seen, documents to be obtained and things to be done whilst the researcher was in the school. The protocol was a standard set of instructions, like a script, to be read out by the person administering the tasks. A classlist was prepared beforehand listing the number allocated to each student.

The class teacher was asked to ensure that the right student had been given the correct numbered task pack which comprised a plastic wallet containing copies of three extracts from the textbook set out as a cloze task and a booklet in which to write students' questionnaire and cloze task responses (see Appendix D). The use of numbers ensured anonymity. Three colour coded versions of the task directed students to the three cloze extracts in three different orders. The packs were given out in strict rotation of colours, commencing with different colours on different days, also in rotation. This procedure ensured that equal numbers of students attempted the task and questionnaire in each of the possible orders of extracts, eliminating the effects of student tiredness, loss of concentration or training to the task. Students attempted the students' questionnaire first and were reminded of the time at three intervals during the session. They were encouraged to move on from the questionnaire, their first extract and their second extract. The protocol was read to students who were subsequently given only limited assistance. However, it was emphasised to students that it did not matter if they found the cloze task and questionnare difficult as long as they honestly tried their best. If the textbook was difficult to understand, that was what the research would prove. The research tasks were designed to emulate a classroom situation so talk between students was considered acceptable. However, it was pointed out that students should decide for themselves on their responses. A tape recorder was available throughout the study in order to collect spontaneous informal discussion between students or between students and the researcher. Students were encouraged to record such comments in their students' questionnaire responses.

6.2.4 Outcomes of the pilot study

Following informal conversations with students and teachers during the pilot study, some minor amendments were made to instruments and procedures, for instance, a sentence was added to the protocol to clarify which extract each version of the task started with. Students were satisfied that the students' questionnaire gave ample opportunity for them to express their opinions. All of the comments made in informal discussions with students, which were recorded and reviewed, were also made by students in their students' questionnaire responses. However, it became clear that subjects needed to be encouraged to include these comments in the appropriate students' questionnaire responses. Throughout the study informal discussion, which arose and was encouraged, was dealt with in this way. However, care was taken to ensure that students' responses were not prejudiced by the opinions and attitudes of the researcher or teachers helping to administer the task. Only limited help was given to the students once the task instructions had been read and care was taken not to ask leading questions or to suggest particular responses to students. General impressions formed from these conversations informed the coding of the students' questionnaire data described in Chapter 7 (see 7.3.1).

The cloze task and students' questionnaire and discussion task fitted double lessons of 70 minutes. Time availability was mentioned as a problem in all schools but teachers felt that the time required for these tasks was not excessive. A general impression from the pilot study was that students of all abilities could follow the instructions given and were able to complete the cloze task and questionnaire to the best of their ability. Students were interested in the research and were keen to give their opinions about the textbook. The kit lists, procedures and protocol were an aid to consistency and quality control throughout the study. There were long gaps between bouts of data collection (Summer 93, 94, 95) and the author wanted to ensure consistency and reliability through use of the same procedures. The procedure for writing up transcripts (see Appendix B) was also standardized.

6.2.5 The main study

Planning began for the main study once the pilot study had been completed and amendments and adjustments made. The amendments and adjustments to procedures were of a minor nature, the main research instruments remaining the same. It was therefore possible to use the data collected during the pilot study as part of the main study. The pilot study schools were included in the main study. As explained above they provided a broad range of schools and the preliminary data collected could be included in the main study. A further ten schools were selected which supplemented this small sample of schools. The main study sample included at least four examples of each of the types of school described in section 6.2. The sample also included a special school and single sex schools. The cloze task and questionnaire were administered to all Year 10 students studying the Nuffield Co-ordinated Sciences course in the pilot study schools during the Summer Term of 1994. In addition preliminary visits and trial runs were carried out in eight of the additional schools during the Summer Term of 1994. Data from the pilot study and these trial runs were included in the data used for analysis where the course was used with students of a narrow range of ability. These samples were relatively homogeneous. The data from the pilot study and trial runs were not included in the analysis of data from schools which used the course across a broad range of ability. These samples were heterogeneous and findings might be biased by the addition of data from the pilot study and trial runs. In two of the additional schools, data was collected from all Year 10 students during the Summer Term of 1994 without a trial run. One of these schools was an overseas school and transport costs restricted the researcher to one visit. The other school was to be inspected during 1995 and teachers did not want the data collection to occur during the inspection. Three schools dropped out of the study after the preliminary visit and trial run during the Summer Term of 1994. In one case the school dropped out because they changed to a different course. In the second case teachers were concerned about the time taken up and disruption to the curriculum. The third case was the special school. In this school teachers expressed concerns about the difficulties which students had in completing the cloze task.

6.2.6 The sample

Various factors such as geographical spread, gender and the extent of bilingualism, were taken into account in choosing from the 37 schools which had responded positively to the initial enquiry. The school profiles describing the three schools which dropped out of the study (Schools 1009, 1019 & 1022) are included in Appendix A. Appendix A also contains a profile of a school where students were interviewed about the textbook studied in 1996 (School 1039). These profiles of schools which were not involved in the main research study have been included because they provide useful general information about the schools using the Nuffield Co-ordinated Sciences course and textbook studied.

The sample of twelve schools which participated in the main study included representatives of each of the three groups described in section 6.2. Representatives were selected from each group which had more than, and less than, 10% bilingual students. There are two boys' schools in the sample, (1021 & 1031). Unfortunately a girls' school (School 1022) dropped out of the study. The geographical distribution of the schools showed broad agreement with a sample from the Nuffield User Schools database. Schools from two counties, Hertfordshire and Kent (Schools 1035 &

1031), represent clusters of user schools. The wide geographical spread of the sample ensured the linguistic diversity of the students taking part in the study. Half of the schools selected had more than 10% bilingual students. These were matched with similar schools with less than 10% bilingual students. In addition to the state comprehensive schools under Metropolitan Authority and County Council control and with Grant Maintained Status (GMS) the sample included independent schools, one of which is overseas. The sample includes a Roman Catholic School (1036) and a Church of England School (1029).

The sample schools reflect the wide range of selection and setting policies found in English and Welsh schools. From selection by a 12 Plus examination, (School 1007) and Common Entrance (School 1021) to selection on religious grounds (Schools 1036 & 1029) to open admission (e.g. Schools 1011 & 1035). Some of the sample schools which took students of all abilities used the course with all their students (e.g. School 1011), in others it was only used with more able students (e.g. School 1020). In some cases setting arrangements were based entirely on ability in Science (e.g. School 1035), in some on ability in mathematics (e.g. School 1011) and in others in ability in several subjects (e.g. School 1021). In some schools setting was organised across entire year groups (e.g. School 1035), in others across half year groups (e.g. School 1028). None of the participating schools operates a policy of mixed ability teaching in Science at Key Stage Four. The classes studied include students of a wide range of ability with a bias towards more able students. There was anecdotal evidence (see Appendix A) to suggest that this was the expected audience for the course.

> "*The most likely target pupil was at the upper end of the ability range*" [Turvey 1993].

Data about this sample of 12 schools and the students who participated in the study are summarised as Table 6.1. The sample studied in each school included all the students in Year 10 in either 1994 or 1995 who followed the Nuffield Co-ordinated Sciences course. As explained above, the data collected during the pilot study and trial runs was also included in some cases. In one School (School 1020) where only two classes in each year group use the Nuffield Co-ordinated Sciences course, data was collected from two Year 10 groups and the pilot study.

Table 6.1: A summary of the sample

School Number	Boys	Girls	Total	Bi/multi-lingual students		Number of languages spoken in addition to English in the classes studied
				Number	%	
1004	35	39	74	24	32.4	18
1007	65	70	135	11	8.2	10
1010	55	58	113	11	9.7	4
1011	92	73	165	9	5.5	7
1018	29	45	74	64	86.5	4
1020	46	56	102	46	45.1	16
1021	133		133	43	32.3	21
1028	82	69	151	2	1.3	2
1029	41	57	98	8	8.2	5
1031	165		165	30	18.2	17
1035	84	55	139	6	4.3	8
1036	86	85	171	18	10.5	9
TOTAL	913	607	1520	272	17.9	59

The sample provided data about approximately 80 classrooms, including many which contained bilingual and multilingual students. The samples from schools include those where over fifteen languages are spoken but less than a third of the sample population are bilingual (Schools 1004, 1021, 1031), one where a few languages (4) are spoken in addition to English but where the majority (87%) of students are bilingual (School 1018) and others where less than 5% of the students are bilingual (Schools 1028 & 1035). School 1004, serves a British community within a European bilingual environment, whilst School 1018, serves a bilingual community within a predominantly monolingual English environment. In addition, the sample includes speakers of a wide range of cultural and social dialects and combinations of regional dialects and bilingualism. The study covers bilingualism spanning African, Asian, Oriental and Mediterranean, Northern and Eastern European languages. All together, speakers of more than sixty languages took part in the research. Class sizes varied considerably within the sample, from those which normally consisted of about a dozen students to those of over thirty.

6.2.7 Research and INSET

As a token of gratitude for their co-operation, participating schools were offered various INSET packages. One INSET package involved the preliminary research study carried out on the textbook and reported in Chapter 5. The Textgrader 2 software discussed in Chapter 5 (see 5.3.1) was taken into schools along with the extracts of the textbook already committed to computer file. Then textbook and teacher generated materials were examined with a view to improving them. Staff were briefed about the findings of the preliminary text and figures analyses and readability in general discussed in Chapter 5 (see 5.3-5.4.2). INSET packages based on the discussion task, and others concerning differentiation in Science and GNVQ Science were also offered.

Most participating schools took up these offers. With the present financial constraints on schools and advisory services, but the continuance of INSET days and the speed of change in education, perhaps this strategy is a way forward for both researchers and schools. This approach to INSET embraces Stenhouse's [1984] concept of "*the teacher as researcher*" and encourages "*the reflective teacher*" [Open University 1990 pp. 30-33, Schon 1983 pp. 326-354]. INSET provides a way to ensure the dissemination of research findings to the places where it might have some effect. INSET extends dissemination and makes the findings more accessible to teachers. Ruddock [1986] compares this method of dissemination with dissemination of research findings through large scale conferences. She concludes that,

> "*The school based curriculum development movement has a better chance of building new meanings within the working group as a basis for new practice*" [Ruddock 1986 pp. 214-215].

She emphasises the need for teacher ownership of innovation for it to be successful [see also Johnston 1988]. Fullan [1982] sees,

> "*carrying out action oriented research as a collaboration between researchers interested in the process of change and practitioners interested in promoting and evaluating specific change projects*" [Fullan 1982 p. 197],

as a way of ensuring the effectiveness of curriculum development.

6.2.8 Consistency and Reliability in data collection

Consistency and reliability are issues to be addressed in any research study. In this research there were long gaps between bouts of data collection which made quality control in data collection an important issue. A series of documents were written about each task involved in the research and its administration (see Appendix D). These documents were used to ensure consistency and quality control within the execution of the research methodologies, to train a research assistant and as prompts for teacher researchers who helped administer the research tasks. During the coding of responses, response directories were written to ensure consistency and quality control in coding data. A standard form of computer spreadsheet was developed during the pilot study to deal with all the data sets from the cloze tasks. A standard form was also developed during the transcription of the pilot run of the discussion task for the presentation of these data (see Appendix B). Comparisons between the various data sets are more reliable when the data are presented in a standard form. One of the aims of the pilot study was to try out the checklists, procedures and instruments. Once these methodologies had been tried out and adjusted in the light of the researcher's reflection and reflexion, student comments and teachers' feedback, they were not amended any further. A detailed description of methods was written up during the pilot study. This information was read through at the start of each subsequent research season.

Generally the researcher administered the research tasks. However, occasionally it was necessary to run two groups of students through research tasks simultaneously. Wherever possible, the researcher's assistant was a teacher in the school in question who had been present on a previous occasion when the cloze task and questionnaire had been administered and who was the regular class teacher. These teachers were encouraged to be involved in the work as *teacher researchers* [Hopkins 1985 pp. 1-3]. On all of these occasions, the teacher in question was briefed beforehand, was given the relevant documentation as prompt material and was reassured that the principal researcher was available to sort out any problems. A research assistant who had not been present at a research session was trained to administer the task at School 1004. This session was recorded on tape and used as reference material. The research task documentation and the overall philosophy of the research were discussed. A reflection on this tape by the author informed his dealings with teacher researchers throughout the rest of the research study. The administration of the cloze task and questionnaire by other researchers was a means to evaluate the research instruments and procedures and to collect some feedback concerning their validity and reliability.

6.2.9 Follow up questionnaires and interviews

The final stage of the research involved detailed work with a limited number of students. Teachers administered follow up questionnaires (see Appendix D) to two groups of students who had attempted the cloze tasks in each of three schools. In two schools, where the textbook was only used with more able students, all the students in the year group who followed the course, took part. In a grammar school two representative classes took part. The first two schools were the subject of detailed analysis of particular language communities discussed in Chapter 7 (see 7.4.4). The third school was selected in order to provide data for comparison. These questionnaires were short multiple-choice response tasks which took students about ten minutes to complete. All of the teacher researchers involved had administered the cloze task and the main students' questionnaire and were given instructions and a procedure for the administration of this extra task. The purpose of administering the questionnaire was to find out about the extent of the use community languages by students in these schools. The follow up interviews comprised group discussions between the author and small groups of students. The purpose of these follow up interviews was to test the inferences drawn from the main research data.

6.3 Research methodologies

Various methodologies were used in the research. Some data were collected through formal and informal interviews. The formal interviews made use of specially prepared interview schedules. In all, four different questionnaires were used during the research. These differed in form and purpose. Two tasks based on the textbook studied were developed for use within the research, a cloze task and a discussion task. Various administrative documents were developed during the organisation of the study including a protocol, procedures, kit lists and directories of responses. The study also made extensive use of computer systems. Computer databases and spreadsheets stored information about schools. Raw data were coded into computer spreadsheets and then separate computer spreadsheets were written to process the data ready for analysis.

6.3.1 Questionnaires

The questionnaire questions used in the initial enquiry to schools in 1992 (see Fig 6.1) comprised the third part of a questionnaire, sent out by the Chief Examiner of Nuffield Co-ordinated Sciences, concerning continuous assessment and records of achievement in science and the provision of separate sciences syllabi.

Figure 6.1: Questionnaire item

> Information requested for a research project on the use of text within Nuffield Co-ordinated Sciences.
>
> 1. How many bilingual students are there in a typical Nuffield Co-ordinated Sciences group in your school?
>   A. 2 or less
>   B. Between 6 and 2
>   C. Between 10 and 6
>   D. More than 10
>
> 2. Is this number typical of Key stage Four groups throughout the curriculum? YES/NO
>
>   If your answer was "No" please comment further.
>
> 3. Would you be prepared to take part in a research project investigating the use of text within Nuffield Co-ordinated Sciences? YES/NO

These questionnaires were sent out with a Nuffield Co-ordinated Sciences newsletter. The questions were designed to be as brief as possible and to elicit useful information which science teachers would have easily at hand. As explained in section 6.2.1, the main purpose was to identify schools worth following up, rather than to collect a great deal of information about schools.

Each of the students who took part in the research completed a questionnaire (see Appendix D) which was administered at the same time as the cloze task. The questionnaire was completed anonymously but students were allocated numbers so that any particularly interesting responses could be followed up. Care was taken to keep the number of words which students had to read down to a minimum and to make the language used as simple and unambiguous as possible. Those students who regularly benefited from classroom assistance had that help during the tasks.

The first part of the students' questionnaire identified the student and the school by number. Students also wrote down the date, the class identifier, their age and gender. The next part of the students' questionnaire consisted of a series of short open-ended questions which elicited information about their opinions and attitudes to the textbook. Following the practice used in writing examination papers, the number of lines provided for responses indicated the length of the responses expected. Students who entered into informal discussions about the textbook with the researcher were encouraged to record their observations in this second, open-ended, section of the questionnaire. If students found that they had insufficient space to write their responses they were encouraged to finish their comments on the back of the responses booklets. Students were also asked to write down the languages which they spoke at school and at home in this section. In the third part of the questionnaire, questions with multiple choice responses were used to elicit information about how often students thought they used the textbook, how they used it, where they used it and the edition of the textbook they generally used.

A similar, but slightly longer, questionnaire was completed by teachers (see Appendix D) in order to provide comparative data. This version of the questionnaire included more space for general comments about the book and elicited information about how teachers introduced text to classes. Teachers were also asked to give information about how any texts had been used with each class during the four weeks prior to the administration of the research tasks. In order to economize on teachers' time, most questions were of the multiple choice response type. A grid was provided in which teachers wrote the information about the use of the textbook over the previous four weeks.

The follow up questionnaire (see Appendix D), which was administered to limited numbers of students in three schools, concerned the extent to which students used their bilingualism. All the respondents had previously completed the student questionnaire described above and it was possible to match the information which they provided in the two questionnaires through their student numbers. The first section of this questionnaire concerned School, student and class identifiers. The rest of the sheet concerned 18 ordinary situations in which students might use English or another language, for example, "*Talking to friends at breaktimes*". For each situation, students were invited to circle one of five options, A Always English, B Mainly English, C Equal amounts of English and another language, D Mainly another language, E Always another language, to indicate their language use in each situation.

6.3.2 Interviews

Prior to this research study, the author had had experience of interviewing adults when working as a writer on various publications. He had also interviewed students during small scale research studies into the use of language in science classrooms. The first part of each interview with a Head of Department was used to create as relaxed and informal an atmosphere as possible. All interviews were taped and very few notes were made in order to put the interviewee at their ease. Once started, the tape recorder was left running and a continuous tape machine which uses both sides of a 45 minute tape was used. Two interview schedules were developed in advance of the pilot study for use during interviews with Heads of Department. These were basically lists of topics which the author wanted to cover in the school profiles. As the conversation progressed the interviewer ticked off the topics covered. One schedule covered school policy and resources (i.e. the institutional environment), the other covered departmental teaching and resources (i.e. the classroom context). Copies of these interview schedules are included in Appendix A. The tapes were later replayed and the school profiles written up. Additional information from other documents such as school prospectuses, Ofsted reports, policy documents and Department Handbooks was incorporated as appropriate. A common format was developed for these profiles so that, when completed, comparisons could be made. The profiles were checked and updated by the interviewees during subsequent visits. As an additional check on the methodology two developing profiles (Schools 1004 & 1039) were discussed with an experienced teacher who acted as a research assistant in these schools. This independent observer was satisfied that the profiles gave unbiased accounts of the schools and Science Departments. One Department (School 1018) used the profile in a formal discussion about the Department between members of the Department, the Headteacher and a school governor. This Department considered the profile to be a good summary of their past achievements and future goals.

Most of the taped material collected from students was collected informally as they attempted the research tasks or chatted with the researcher. It was intended that towards the end of the study, in November 1996, more structured interviews would be carried out with students in order to test some of the inferences made from the findings. It was decided that both boys and girls and monolingual and bilingual students should be interviewed. Of the six schools with more than 10% bilingual students which took part in the research, one is overseas and was ruled due to the cost of transport, two are single sex schools and the remaining two schools had dropped the Nuffield Co-ordinated Sciences course by 1996. Fortunately, School 1039 agreed to take part in this last phase of the research. It is a GMS coeducational comprehensive school where all of the students in the year group studied follow Nuffield C-ordinated Sciences courses. About 10% of the students attending School 1039 are bilingual. One might argue that testing inferences in a fresh situation in this way strengthens rather than weakens the support provided to inferences.

At School 1039 a quiet room which was separate from teaching rooms was made available to the researcher in which to carry out the interviews. Two single sex groups of four students, which did not include any dominant members, were selected by the teacher responsible for biology in the school. These groups included 5 bilingual students. Each group of students was interviewed for about 20 minutes. On arrival at the interview room the group of four students was divided into friendship pairs. A separate tape recorder recorded the conversation between members of each of these student pairs. Each student was asked in turn to identify themselves so that the voices on the tape could be distinguished. The tape recorders were then left running for the rest of the research session.

The pairs were asked to put nine phrases used to describe of textbooks, which had been printed on to cards, into order of priority. The statements were, *Good layout*, *Clear diagrams*, *The use of clear language*, *A clear structure to the whole book*, *Scientific diagrams*, *Science in everyday contexts*, *Attractive design*, *The use of scientific language* and *A glossary*. The students were asked to imagine that the statements might contribute to their choice from a selection of textbooks. These particular phrases were chosen in the light of the findings of the main research study reported above.

When each pair of students was satisfied with the order of priority chosen, this order was spoken into the tape recorder as a record of the outcome of the activity. The pairs of students were then asked to compare the two orders of priority and to produce a joint order which the four of them agreed on. Later this joint order of priority was also spoken into the tape recorder. Once the students had completed this task they were asked the questions in the second section of the students' questionnaire described in section 6.3.1. Before they were asked the question, "*Which languages do you speak at home?* ", they were told that they did not have to answer the question if they did not wish to. The data collected, i.e. taped conversations and orders of priority on tape, were reviewed and analysed.

6.3.3 Cloze procedures

A cloze task is based on a text where every *nth* word is deleted from the text. Students are invited to supply the correct words to fill the gaps. As Graham [1978 pp. 547-548] points out, this strategy examines students' grasp of the style and vocabulary of a text as well their grasp of its meaning. Rye [1983 pp. 150-151] explains that the approach encourages subjects to use their own resources and to reflect on what they have just read. Shrauger [1976] found the percentage score on the cloze procedure useful for estimating students' chances for success in understanding content area textbooks. Cohen and Poppino [1978 pp. 443-446] showed that cloze procedures could be used effectively with biology textbook material to identify students who would benefit from study skills support. Graham [1978 pp. 547-548] and Thelen [1974] discuss the use of cloze procedures to assess the *readibility* of science textbooks in some detail. Williams [1983 p. 112] used cloze procedures in a study of textbooks for overseas students taught in English. Cloze procedures were also used in a recent national survey of literacy competence in Scotland [Mulholland & Neville 1989] and in a study of textbooks written in Hindi [Agnihotri & Khanna 1991/1992]. Bensoussan [1990] cites various studies [e.g. Arnaud 1981, Berkhoff 1976] which, like her own research, use cloze techniques in English with non-native speakers of English.

Harrison [1980b pp. 84-108] found that although cloze procedures work differently in some subject areas, there is a good correlation in results with formal reading tests. Cloze procedures obviate the need for time consuming test item construction and they do not just predict difficulty with a text, as Bailey and Harrison [1984 p. 186, Merzyn 1987] point out, they measure the difficulty directly, involving people actually reading the text in question. Cloze procedures address contextual issues in textual understanding. Cloze procedures take account of meaning, the sequential nature of language and the maturity of readers. They measure a "*recalled comprehension response*" [Bailey & Harrison 1984 p. 186] which includes understanding of meaning within sentences as well as understanding due to cohesion between sentences. Consequently, cloze procedures can probe scientific grammar and deal effectively with science register meanings of everyday words. They also pick up effects attributable to genre and writing style.

If factors such as illustrations, type and paper, match the source as closely as possible, cloze procedures are valid and reliable. The method has the advantage over the novel, untried, multiple choice or comprehension tests, which could have been used in this research, in that there is a literature available [Bormuth 1967, Rankin & Culhane 1969], linked to standardized American scores in multiple choice and comprehension tests, which will help in evaluation and interpretation. The scientific grammar, scientific lexis, genre and writing style aspects of textbook understanding could be probed through further data analysis of specific deletions within a cloze task.

The question of whether the task is a different kind of task for different kinds of reader is not a serious problem [see Neville & Pugh 1976/-7]. Contrary to Bormuth's [1965 p.285] research findings, one might argue that "*single word*" cloze tasks reveal less about student understanding of concepts than part or whole sentence deletions. One might also suggest flexibility on counting synonyms and similar explanations as accepted responses. The author agrees with Bormuth on this point. If synonyms and alternatives are accepted, consistency and comparability of data becomes a problem. The objectivity of the research findings may be jeopardized if the researcher's opinions and reading of the text in question affect the classification of responses.

Bailey and Harrison [1984] show how readability and comprehension might be related to cloze scores.

> *"[cloze] gives an index of language behaviour communality, the degree to which the communicative habits of the source correspond to those of his readers (readability) or the degree to which the communicative habits of a receiver correspond to those of some standard source (comprehension)."* [Bailey & Harrison 1984 p. 188].

Cloze tasks may actually measures the *"redundancy"* of text [Bailey and Harrison 1984 p. 188]. The author considers *a lack of redundancy* to be a difficulty with most science texts. Chapman and Louw [1986 pp. 9, 18] attribute the *"peculiar success"* of their Perception of Textual Cohesion Project to a *"gap"* technique. They point out that each gap which is filled,

> *"represents the child's own creation of meaning. Children make their choice from the resources of language available to them"* [Chapman & Louw 1986 pp. 9].

They describe filling a gap as a three way tug, one towards structure, another towards cohesion and a third towards fulfilling a register requirement. Dolan, Harrison and Gardner [1979 p. 136] describe cloze tasks as *"short bursts"* reading (see Chapter 2: 2.3.2).

6.3.4 Cloze tasks and the research study

In order to investigate the accessibility of school science textbooks, this research aims to probe the relationship between readers and the textbook studied, the effect of redundancy and the creation of meaning. Structure, cohesion and register are important aspects of scientific text and as such are of interest to this research. A cloze procedure probes these features of text and encourages the *short bursts* reading strategy which, as discussed in Chapter 2 (see 2.3.2, is common in science classrooms.

Three contrasting passages were chosen from the Nuffield Co-ordinated Sciences Biology textbook (A copy of the task is included in Appendix D, the results of the text analysis of the three extracts are presented in Table 5.c in Appendix C). The numbers in each heading refer to the book section which the extract is taken from, e.g. section B6.1 is the first part of Chapter 6. Davies and Greene [1984 pp. 91-98], would describe the first extract, *B6.1 What would you like for supper tonight?* and *B6.2 Why do you need food?* [pages 61-63], which lists and explains the components of a balanced diet, as a "*classification*" text. In their classification [Davies & Greene 1984 pp. 98-112] the second extract, *B12.4 What goes in must come out?* [pages 151-152], which explains the need for water balance and the functions of the kidneys, is a "*mechanism/structure*" text. Davies and Green [1984 pp. 108-111] would describe the third extract, *B18.2 Conservation* [pages 225-226], which explains the need for conservation and long term ecological processes , as a "*process*" text. This third extract was the least self-contained of the passages chosen.

Following Harrison's [1980b p.101] suggestion, each extract was taken from the beginning of a section. The findings from the readability study reported in section 5.3.2 showed that the reading levels of captions were quite erratic. A deletion in a heading or caption could render a whole passage or figure inaccessible and the highlighted questions relate to independent classroom tasks. Consequently, only main prose text was used for the cloze task. Headings, captions and highlighted questions, were included in the extracts presented to students but were excluded from the deletions which comprised the task itself. The prose style ranges from the "*context seeking*", to "*expositional*" standpoints within Davies and Greene's taxonomy [1984 pp. 89-132]. Each piece of text was supported by at least one figure. The figures included photographs, a table of data, diagrams and a map. All three passages include code switches. In the Kidneys extract, the reading level increases from 12 to 15 over a switch from scientific discourse in Standard English using scientific grammar to scientific discourse using Standard English, scientific grammar and scientific lexis (see Chapter 5: 5.3.2). There were no noticeable changes in readability score over switches in the Diet extract from the science register to teaching discourse in Standard English *and back* and in the Conservation extract from everyday discourse in Standard English into scientific discourse in Standard English.

The written text of these extracts is the same in the two editions of the textbook. It is set in the same type face with the same spacing and fonts. The most significant difference in these extracts between editions is in Figure 6.1. "*You are what you eat*". In the new edition a figure representing an Eastern style meal replaces one showing a Western style meal. It would have proved more expensive to produce a cloze task based on the new edition than one based on the old edition due to the amount of colour photocopying required. The old edition was available on computer disc and would be easier to reset to include gaps, using a desk top publisher. This procedure could have been adapted to produce the same effect as the new edition. However, there were problems in resetting the text with coloured backgrounds in the right colours. Also, at the time of the study, uptake of the new edition was limited [Pevsner 1993, Appendix A]. Preliminary school visits during the pilot study confirmed that there were few copies of the new edition available in participating schools. For these reasons the task was based on the old edition.

Although fifth word deletion is widely used, Harrison [1980b pp. 101-102] suggests that seventh word deletion is more suitable for use with weak readers and difficult passages. Weak readers are of particular interest in the context of this study and it was important to the differentiation of competence that even students who found the task difficult could provide some responses. Consequently, seventh word deletion was chosen for this study. When counting out the words for deletions, hyphenated words were treated as single words. Each passage was about 350 words in length giving 50 or so deletions. Harrison [1980b p.101] considers such an arrangement to produce a reliable research instrument. Bormuth [1969 p. 717] used this format in a similar study. This format fitted the style of the textbook, producing three reasonably self-contained texts to work with. Following Harrison's [1980b p. 102] suggestion, the deletions within the task were made a standard twelve *ems* long. Spaces were numbered and students filled in their responses in special booklets. After careful consideration, a misprint was left in the task. It was viewed as a difficulty which all students encounter when reading this textbook and as such was part of the accessibility problem set by the text.

As Graham [1978, 1981] has pointed out, there are seven possible versions of each cloze task extract. There are 343 versions of the whole task involving three extracts. Graham [1978, Davies 1976] found that inter-version variations are statistically significant. Inevitably, the choice or versions used in the task were based on compromises and priorities. The version of each extract with the first word deleted was rejected on the grounds that students might find this off-putting. Versions were examined for the deletion of words referring to figures and experiments on worksheets not included in the cloze task materials and this was taken into account.

The version of each extract chosen reflects the number, distribution and repetition of deleted scientific lexical words. Versions where technical words were deleted on their first occurrence were also avoided.

David Wright of NCCT reset the extracts using a desk top publisher, making them as close as possible to the original texts but including the 7th word deletions. For technical reasons the headings were set in a slightly different font to the original and the text typeface was slightly different (the original was set on a printing machine, the reset was desktop published). The passages were photocopied in monochrome. The illustrations were colour photocopied and stuck on later. The extracts were printed back to back and were laminated to make them durable. The sheets were presented to students in plastic wallets. David Wright also set the student response booklets (Appendix D) for the task to make them look professionally produced. Three versions of these booklets present the extracts in each of three different orders. These were colour-coded, blue, yellow and pink. The corresponding student number cards were also colour-coded. The booklets comprised, a student questionnaire and three proformas on which to write responses to the deletions in the three passages. Students were also asked to indicate whether they had read each passage before.

On Dieter Pevsner's advice, the numbers labelling the deletions were set in bold type in squared brackets in the same font as the text and were set in the middle of each space. It turned out that each page of reset text was about five or six lines longer than the original, an indication of the number of short words included as deletions. The page shape of the textbook differs slightly from A4, the page shape used for photocopying. It is about 5 mm wider and 20 mm shorter. However, it was possible to fit the text column width found in the textbook on A4 paper. The piece of the margin lost on these loose leaf pages accounts for the loss of visible page where it bends to fit into the binding of a copy of the textbook itself. The A4 page length was used to fit the text in, keeping each extract to two pages. This layout resulted in pages which, although they were a slightly different shape, each included the same text, and was laid out, as the original.

The picture quality was within the range found in five copies of the textbook chosen at random. However, the colour photocopier did not pick up the grey background on figure 18.6 and the blocks of colour had a slightly patterned effect. To allow for slight enlargement during photocopying an extra 2 mm was allowed on each dimension of the figures to ensure that they would fit on the texts as presented. Features such as page numbering, the grey shading under questions and margin symbols were copied exactly.

One of the participating schools is a Special School (School 1009) catering for some blind and partially sighted students. Some of the students in this school *read* by listening to audio tapes through headphones. An audio taped version of the cloze task was prepared for these students [see also Mulholland & Neville 1989]. It was as similar as possible to the paper task. The task reader has extensive experience of reading aloud to children. Example tapes were played and features such as rhythm, pace, stresses and intonation were noted. The form of references to page numbers and figures etc and the overall style of presentation were noted. The taped task was a close copy of the taped text except, of course, for the gaps. The task employed an identical style of introduction and presentation for each section. It used the same conventions and axioms in references to page breaks and figures. It used the same pace, rhythm, intonation and emphasis. The task protocol (see 6.3.9) refers to information written on a board. This information was also read on to the tapes (see Appendix D). The gaps were included as speech, that is, it sounds like this, "*Most, Gap 1, eat such a varied diet that, Gap 2,*" and so on, so that students knew which gap was which. The reader continued the rhythm and pace of the reading independently of announcing the gaps. Students made their regular use of the tapes, classroom assistants and other special classroom aids like closed circuit TV, used to enlarge the print of the printed task. Rewinding the tape was judged to be the same activity as scanning back through the text in reading.

The cloze task and questionnaire were designed to fit a double period of seventy minutes duration. Harrison [1980b p.103] recommends that students should be given as much time as they need to complete such exercises. However, it is debatable whether this reflects the situation in the classroom and it may introduce bias into the results of the research [Harrison 1980b pp. 49-50]. The length of lessons in the schools involved in this study varied from 50 minutes to 100 minutes (Appendix A). Although it is important to enable students to perform at their best, it is also important to emulate the normal classroom situation. Pragmatic considerations such as the number of lessons disrupted by the study and the difference between lessons involving the task and *normal* lessons were also taken into account. When the time available was tight, sessions were started promptly and occasionally spilled over into breaks or lunchtimes. When extra time was available, an extra activity (usually looking through the extracts in the book) was used once the task materials had been collected from students. The vast majority of the students involved in the study completed as much of the task as they could manage in the time available and said that they had finished. Checks with regular members of staff confirmed that certain students who failed to complete the task were behaving in the manner in which they approach tasks based on the textbook during normal lessons. Thus their performance mirrored the usual classroom situation. This lack of application is a motivation problem which should be reflected in the data collected.

6.3.5 Readability analysis of the cloze task text

Each of the extracts was divided into three parts of about a hundred words in complete sentences. These sections were analysed by readability formula [Fry 1968, 1977, see Chapter 5: 5.3.1-5.3.2, Table 5.c in Appendix C]. The results are presented as Table 6.2.

Table 6.2: Reading levels for the three extracts

	Reading Levels			
EXTRACT	Sect 1	Sect 2	Sect 3	Average
B6.1 & B6.2 (Diet)	14.7	15.3	15.0	15.0
B12.4 (Kidneys)	12.6	12.2	15.2	13.3
B18.2 (Conservation)	14.9	14.0	12.6	13.8

The extracts cover a range of readability levels from 12.2 to 15.2. reflecting the reading level of the textbook (see Chapter 5: 5.3.2). Extract 1 sections **B6.1 & B6.2** is an even text, in terms of reading level, despite the fact that section 2 contains two teaching discourse messages solely in Standard English. The reading level is approximately equivalent to the chronological age of the students involved in the research.

Although Extract 2 section **B**12.4 starts at the relatively lower reading level of about 12, there is a sharp change in the reading levels calculated between sections 2 and 3. This passage was identified as a code switch in Chapter 5 (see 5.3.2). In order to investigate the code switch further, a series of overlapping passages from section B12.4 were prepared of about a hundred words each in complete sentences. The results of this analysis are presented as Table 6.3 (see also Table 5.c in Appendix C). Section 2.1 was prepared by deleting the first sentence of section 2 and adding the next after it, at its end. This process was repeated with successive sections until the last passage in the series was the same as section 3.

Table 6.3: Reading levels for a series of 100 word passages from sections 2 and 3 of Extract 2 (section B12.4)

Section	Reading Level	Section	Reading Level
2	12.2	2.6	13.5
2.1	12.6	2.7	14.4
2.2	12.2	2.8	15.1
2.3	12.2	2.9	15.2
2.4	12.3	3	15.2
2.5	13.0		

This analysis reveals that the increase in difficulty is quite dramatic, within a few sentences and is associated with an increase in scientific lexis after deletion 36, the word "*So*" in,

> "*So it seems that the amount of water in our bodies is controlled. Two organs are especially concerned with this - the kidneys. The position of these bean-shaped organs is shown in figure 12.11.*" [page 152].

In Extract 3 **B**18.2, reading levels progressively decrease from 14.9 to 12.6, indicating it to be a fairly straightforward text at a reading level equivalent to, or slightly below, the chronological age of the students studied. Extract 3 starts with everyday discourse expressed in Standard English and switches into scientific discourse with scientific grammar at the end of the first paragraph. The readability scores (see Table 6.2) do not reflect this discourse switch. All three extracts include switches into teaching discourse and back again, these discourse switches do not affect readability scores.

There is a well established link between cloze task performance and reading achievement [Kletzien 1991 p. 71, Rankin & Thomas 1980]. Bormuth [1969 p. 716, 1967, 1968] was the first researcher to link percentages of correct responses in cloze tasks with the established American "*standards of suitability*" or "*criterion reference scores*", matched against comprehension test scores and presented in Table 6.4. The standards of suitability were first set out by Thorndike [1917] and are advocated by various authors [e.g. Rankin & Culhane 1969]. These standards of suitability were categorised as an "*independent level*", an "*instruction level*" and a "*frustration level*" of reading. Materials are suitable for use in the student's "*independent unsupervised study*" if the student can answer at least 90% of comprehension questions about them. "*Supervised instruction*" indicates that students can answer 75% of questions or more. If a student can only answer less than 75% of such questions, study of the materials is thought to result in "*frustrations which cause the student to develop negative attitudes towards instruction*". As Bormuth [1969 p. 716] points out, this scheme has proved useful to many teachers. It was useful for this study.

Table 6.4: Percentage comprehension scores and cloze scores

Study	75% level	90% level
Bormuth 1967	38%	50%
Bormuth 1968	44%	57%
Rankin & Culhane 1969	41%	61%

Since these levels were published, various American authors have reviewed them and suggested changes. Bormuth himself [1969 p. 720], suggested levels at 37% and 65% in circumstances where interest and information gain are taken into account.

Cohen [1975] working with twelve year olds concluded that,

> "*Teachers should not assume that the commonly used 44 percent and 57 percent criteria for instructional and independent levels can be validly applied in the evaluation of cloze performance taken from content area material*" [Cohen 1975 p. 250].

She suggests that content area material poses special problems for students when presented as cloze tasks. However, Shruager [1976], working with college students, found the percentage cloze score useful in estimating students' chances for success in understanding content area textbooks. Cohen and Poppino [1978] successfully used a cloze score of below 40% to identify college students (aged 15-70) taking biology courses who were in need of extra content based study and reading help, effectively identifying a frustration level boundary. Daugs and Daugs [1974 p. 473] worked with fifteen year olds tackling a cloze task based on biology textbook material. They found that the 44% level corresponded closely with "*grade level performance*". Spring [1975 p.131] found 35% was less effective as a grade level indicator with students of the same age.

Two British studies involved Year 10 students. Dangerfield [1981] used a cloze technique based on science textbooks with fifteen year old students with an average reading age above 17 on a Gapadol reading test (a task similar to a cloze task based on non fictional and fictional material). He found that of 349 cases involving 257 students ~~257 cases~~ (physics 147, chemistry 99 and biology 103), there was only one score above 50% and that the rest were "*well below 50%*". Scores amongst a similar size group with an average reading age of 14.6 were "*far lower*". Bailey and Harrison [1984 p.190] compared mean cloze scores with teacher judgements of the difficulty of text. On 16 passages with an average teacher-rated reading level of 13.1, the average cloze score of fifteen year old was 43.6%.

All the studies discussed here, except the last one, employed fifth word deletion. The Bailey and Harrison study used tenth word deletion. The current research is based on seventh word deletions and is thus not directly comparable with any of these studies. The standards of suitability are useful in that they emphasise the *stepwise nature* of reading ability. As the Bullock Report[DES 1975] pointed out, "*there are no grounds whatsoever for supposing that reading progress is a linear process*" [DES 1975 p. 33].

Standards of suitability are useful broad bands within which to classify readings of texts. In the light of the literature reviewed above, the fact that the current research involves seventh word deletions and the fact that the standards will be used to categorise readings rather than to diagnose student's problems, the following levels were used within this research as general indicators of performance. A score of less than 44% was designated as a reading at the *frustration* level, a score between 44% to 56.9% as a reading at the *instructional* level, and a score of 57% or over as a reading at the *independent* level.

Cloze scores were calculated for all the students involved in the pilot study carried out in 1993, by calculating the percentage of correct responses made for each extract by each student. This was a sample of 110 students of a wide range of ability from five different schools (1007, 1020, 1021, 1028, 1036). The results of this analysis are set out as Table 6.5.

Table 6.5: Mean scores for the pilot sample for the three extracts (n= 110)

Extract	Mean Score %	Standard deviation	Standard error
Diet	46.5	17.66	1.68
Kidneys	47.9	15.88	1.51
Conservation	33.7	15.64	1.49

Applying a z-test to these data yields the result that the difference between the scores on diet and kidneys is insignificant but that the differences between both of those scores and the conservation score are significant to the 1% level. The mean scores for the diet and kidney extracts are at the instruction level whereas that of conservation extract is well within the frustration level. 69.1% of students read the diet extract above the frustration level and 70.1% read the kidney extract above this level. However, the figure for the conservation extract was only 24.5%. These results suggest that the diet and kidney extracts are of similar difficulty with the conservation extract being more difficult. Anecdotal evidence collected during the study, through informal interviews with students, supports this conclusion. The average reading levels for the three extracts measured using a readability formula were, diet 15.0, kidneys 13.3 and conservation 13.8 (see Table 6.2). This would indicate that the kidneys and conservation extracts were of similar difficulty with the diet extract being more difficult. Two quite different conclusions could be drawn. First, that either technique is inadequate in some way. Secondly, that they measure different things.

A cloze task takes account of the situation in which reading takes place and factors such as motivation and interest. A cloze task also takes account of style, vocabulary, and meaning together with whole sentence structures and redundancy in text (see 6.3.3). This makes it dependent on cohesion in text as explained in Chapter 2 (see 2.3.4). Perhaps a cloze task picks up difficulties caused by lack of cohesion which a readability formula analysis does not measure. It does not seem unreasonable to assume that the difference in cohesion in the three texts might account for the difference between the cloze task and readability formula results.

However, one should take into account the fact that different groups of students cover the course in different orders (see the discussion in Chapter 7: 7.3.3 concerning helpful and difficult sections of the textbook.). Familiarity with a section, particularly if it has been explained by the teacher in some depth, may influence student performance on the cloze task. Another factor might be the extent of the reader's prior knowledge of other areas of the textbook assumed by the author. If the textbook is used sparingly with a class because it is thought by the teacher to be inappropriate for those students, lack of familiarity or prior knowledge may distort student performance considerably.

Some evidence concerning whether students had read the extracts studied, before they were administered as cloze tasks, was available as questionnaire responses and responses to a questions at the head of each cloze task extract. This evidence from the main study data, summarised school by school is presented as Table 6.6.

Table 6.6: Familiarity: percentages of students who had read each extract before its administration as a cloze task

School Number	n=	Diet extract %	Kidneys extract %	Conservation extract %
1004	74	75.7	16.2	2.7
1007p	135	43.0	25.9	0.7
1010	113	5.3	2.7	0.0
1011	165	11.5	9.7	0.6
1018	74	1.4	0.0	0.0
1020p	102	52.0	4.9	0.0
1021p	133	61.7	24.8	0.0
1028p	151	46.4	18.5	6.0
1029	98	25.5	16.3	1.0
1031	165	42.4	12.7	3.0
1035	139	12.2	10.1	2.2
1036p	171	51.5	57.9	0.6

(*p indicates Pilot study schools*)

Students at schools 1004, 1007, 1020, 1021, 1028, 1029 and 1031 are more familiar with the diet extract than they are with the kidneys or conservation extracts. The relatively high rate of recall of the diet extract at School 1020 may be partly attributable to its use by students within a research project undertaken by three of the five classes who participated in the study. This project lasted for several weeks and focused on the information concerning diet contained in the textbook studied. Students at School 1036 are equally familiar with the diet and kidney extracts. The extract on conservation was unfamiliar to at least 94% of students in all the schools. The extract on the kidneys was unfamiliar to at least 75% of students in all the schools except School 1036.

Students in all the schools were unfamiliar with the conservation extract. The pilot schools were amongst those where the diet and kidneys extracts were most familiar.

Generally speaking the kidneys extract was less familiar than the diet extract. These data might account for the low cloze scores in the pilot schools on the conservation extract but they do not account for the similar cloze scores on the diet and kidneys extracts.

The level of prior knowledge assumed in the readers was investigated by examining the explanation and definition of various words and phrases which are important to understanding. These were divided into four categories.

A. words where the meaning was not explained in the extract and which were not included in the index.
B. words which were explained elsewhere in the textbook.
C. words which were explained within the extract studied.
D. a separate category was created within group C of words defined through the conventions of italics or brackets.

The results of this analysis are summarised as Table 6.7.

Table 6.7: Categories of explanations

EXTRACT	A	B	C	D	Total A, B & C
Diet	21 (55%)	10 (26%)	7 (18%)	5 (13%)	38
Kidneys	26 (70%)	4 (11%)	7 (19%)	2 (5%)	37
Conservation	9 (47%)	8 (42%)	2 (11%)	2 (11%)	19

A complete list of the words categorised, and the categories assigned to them, is included in Appendix C. Although this analysis is somewhat subjective, it does indicate general patterns. The percentage of words not explained within the extract (columns A & B added together) is the same for the diet and kidneys extracts (81% in each case) and is greater for the conservation extract (89%). However, a larger percentage of these words (conservation 42% compared with diet 26% and kidneys

11%) are explained elsewhere in the book than for diet and kidneys.

The textbook relies on the conventions of using italic writing and brackets for definitions within the text. Nine out of sixteen words (56%) explained in these extracts were explained using these conventions. In the conservation extract all of the words explained were explained using these conventions. Unfortunately, the same conventions are used inconsistently to convey a variety of other text messages as well which, as explained in Chapter 5 (see 5.5), may confuse readers. The word "*pollarding*" is defined in the conservation extract in such a way that, although the sentences within the definition are cohesively linked to one another, there are no cohesive ties to link them to the word defined. These findings might indicate that prior knowledge and presentation of definitions are an important factors in the accessibility of text. Information about sentence length and cohesion between sentences in the three extracts is summarised as Table 6.8.

Table 6.8: Cohesion and sentence length

Extract	No of Sentences	Longest Sentence (words)	Average Sentence Length (words)	Sentences with CTs
Diet	21	33	18.4	20
Kidneys	26	29	15.9	25
Conservation	21	29	17.9	15

Sentence length is much the same for the three extracts. The most significant difference between the extracts shown in this table concerns the cohesion of text. The first sentence in any text cannot show cohesive ties with a previous sentence. However, with the diet and kidneys extracts all the other sentences have cohesive ties with previous sentences. In the case of the conservation extract, five out of twenty other sentences had no cohesive ties. This evidence may account for the similar cloze performances on the diet and kidneys extracts compared with the conservation extract.

This analysis of the readability of the cloze task texts produced some interesting findings. There is a discrepancy between the relative readability of the three extracts measured by readability formula and cloze task. Further studies indicated that this discrepancy might be explained through the effect of factors such as, prior knowledge of text, text organisation and text cohesion or through a combination of these factors. The author considers text organisation and cohesion to be important aspects of text accessibility. The failure of readability formulae to recognise these factors is a weakness. The fact that cloze tasks take account of these factors is one of their relative strengths.

6.3.6 Layout and figures

The page layout in this textbook is *recto-linear* (see Chapter 2: 2.6.3) and follows the conventions set out by Goldsmith [1984 p. 404] (2.4). On each page, the figures and text are laid out vertically in a top to bottom format. Sequences of pictures forming figures i.e., Figure 6.2 a, b, c, d, & e and figure 18.18 a, b & c and the sequence of Figures 18.21 and 18.22 read from left to right (see Appendix D). As Kress [1996] points out, this format is a western form of text layout. However, the sequences Figures 12.10 a & b and 18.19 & 18.20 read from right to left. The task extracts include seven figures (an additional figure is referred to in the written text but not included). The number of figures on a page and layout is typical of the textbook. The sample includes photographs, diagrams, a table of data and a map. Figures 6.1, 6.3, 12.10 and 12.11 are discussed in the analysis of figures included in Chapter 5 (see 5.4.1-5.4.2).

The following criteria concerning the effectiveness of figures used in written text are based on Reid's work [1990b p. 256] which is discussed in Chapter 2 (see 2.4-2.4.2).

A. The material to be learnt should be presented in both figure and written text.
B. The learning task should be memory based rather than concerned with high level cognitive activities such as understanding.

C. The amount of information in the figures should not be so great that it *overloads* the ability of the learner to cope.
D. The structure of the figure should be optimized in terms of figure-ground clarity, colour and features which attract and then direct the learner's attention.

An analysis of these criteria applied to the figures included in the cloze task is presented as Table 6.9. Captions and text written on diagrams were included as part of the figures when judging Criterion A.

Table 6.9: The effectiveness of figures

Figures	6.1	6.2	12.10	12.11	18.16	18.17	18.18
A	*				*		*
B				*	*		
C	*	*	*	*	*	*	*
D	*	*	*	*	*	*	*
E	*	*	*	*	*	*	*

The figures have good figure-ground clarity and carry about the right amount of information. However, they score poorly in terms of their relationship with the text and the learning tasks with which they are associated. The importance of this finding is explained in Chapter 2 (see 2.4, 2.4.1). Five out of seven figures were linked with understanding tasks rather than memory based tasks. Four out of seven figure carry additional information to the text. These figures do not complement the text as much as they might.

Figure 6.1 in the diet extract (see Appendix D for the figures listed which were included in the cloze task) is a photograph which depicts various foods, with the caption "*You are what you eat*". One could argue that the caption alone has a host of cultural connotations.

The caption for Figure 6.2 reads,

> "*You will be sure of getting everything you need from your diet if, each day, you eat something from each of the five groups shown*" [page 62].

Figure 6.2 is a photograph showing the various components of a healthy diet. One of these food groups, red meat, chicken and fish, does not include a vegetarian alternative. The written text refers to this figure,

> "*Figure 6.2 shows five groups of food. You can be sure of getting everything you need if you eat some foods from each of these groups every day*" [page 62].

The written text also refers to Figure 6.3 [page 64] which is not included in the extract which was presented to students.

> "*The body can store only a small amount of carbohydrate, although the amount of fat it can store is very much greater (see figure 6.3)*" [page 62].

Figure 6.3 is a monochrome photograph of the world's fattest person, Robert Earl Hughes who weighed 485 kg. In terms of the taxonomy developed in Chapter 5 (see 5.4.1) these figures illustrate the written text.

The written text of the kidneys extract refers to Figure 12.10,

> "*The daily intake and output of water by an average resting human adult*", "*Scientists have measured the daily intake and output of water in an average resting adult in order to investigate this idea. The results are shown in figure 12.10*" [page 151].

One part of the figure is a table, the other an outline of a male human coloured in light flesh tone. This diagram illustrates Kress and van Leeuwen' s [1996 pp. 186-192] (see Chapter 2: 2.3.6) left-to-right rule in the grammar of visual design. The head is twisted to one side in a most unnatural pose. Kress and van Leeuwen [1996 pp. 121-122] interpret this kind of pose as impersonal and objective. The objective attitude neutralizes the relation between the viewer and the representation. The picture suggests that the represented participants are not part of the viewer's world, but other, different. We look at them from the sidelines.

Figure 12.11 is referred to in the written text,

> "*The position of these bean-shaped organs is shown in figure 12.11. See also Worksheet B 12D*" [page 152].

It also has a caption,

> "*The kidneys are positioned towards the back wall of the abdominal cavity, just above the waist*" [page 152].

There is a confusion of colours, flesh tone for the dissected body, reddish brown for the kidney, but red and blue for the artery and vein and bright yellow for the ureters and bladder. The caption includes the passive "*are positioned*". The word "*abdomen*" is not in the index and the phrase "*abdominal cavity*" is not explained in the textbook. The diagram does not depict the space as a hole or "*cavity*". This information is superfluous to a figure which just shows you where to find your kidneys. In terms of the taxonomy developed in Chapter 5 (see 5.4.1) these are both expositional figures.

Figure 18.16 in the conservation extract is a map showing where Epping Forest is. The written text refers to it, but not as a map, "*One example is Epping Forest on the north-eastern edge of London (figure 18.16)*" [page 225]. Central London, which takes up most of the space is only labelled as "*London boundary*". It is not a clear figure. Figure 18.17 is a photograph which illustrates the written text used for the cloze task and is referred to within it.

> "*This woodland was used to provide wood for poles, and to harvest it a system called pollarding was used. (See figure 18.17*" [page 226].

In terms of the taxonomy developed in Chapter 5 (see 5.4.1), these figures illustrate the written text.

6.3.7 The National Curriculum

The relationship between the Nuffield Co-ordinated Sciences course and the National Curriculum for England and Wales was described in Chapter 5 (see 5.2-5.2.3). The course was developed in response to a call for *broad balanced science* courses which predated the National Curriculum. However, the course was operating within the National Curriculum during the period when the research was carried out. The students taking part in this study were covered by Key Stage Four of the 1991 version of the National Curriculum for Science [DESWO 1991]. The parts of the programme of study for Key Stage Four (Double Science) and the statements of attainment [DESWO 1991] accessed by each extract are set out in the Teachers Guide [NCCT 1992a]. This information gives some insight into the aims and objectives of lessons and the level of understanding required of students. The Key Stage Three programme of study indicates the prior knowledge assumed at Key Stage Four. Relevant extracts from the National Curriculum for Science (1991) are included in Appendix D.

A student might access two statements of attainment at levels five and seven from Attainment Target Two of the National Curriculum for Science (Life and living processes) through sections B6.1 and B6.2. The narrow range of levels involved enables the work on the text in the classroom to be narrowly focused. The Teachers Guide [NCCT 1992a p. 81] recommends the use of this text with all students. The Key Stage Four programme of study advocates an emphasis on "*a healthy life style*" [DESWO 1991 p. 24] matching the approach in the extract.

A student might access a broad range of statements of attainment at levels four to ten from Attainment Target Two of the National Curriculum for Science (Life and living processes) through section B12.4. However, the material in this short extract provides only background material for the statements at the higher levels. They are covered in more detail in subsequent sections. Although the Teachers Guide [NCCT 1992a p. 129] recommends that the extract need not be used by students operating at levels four, five and six, the material is relevant to all students.

A student might access a substantial statement from the general introduction and statements of attainment at levels four, six and seven from Attainment Target Two of the National Curriculum for Science (Life and living processes) through section B18.2. The section also supports statements at the highest levels. The section builds on Key Stage Three work [DESWO 1991 p. 16]. The Teachers Guide [NCCT 1992a p. 167] suggests that this extract could be replaced by one of the course worksheets.

The extracts chosen access the whole range of National Curriculum levels covered by the Nuffield Co-ordinated Sciences course (levels four to ten) and general introductory statements in the Key Stage Four programme of study. All three extracts are included in the "*central route*" of ways through the material suggested in the Teachers Guide [NCCT 1992a pp. 81, 127 & 167].

6.3.8 The discussion task

A discussion task elicited thoughts from students and teachers about the cloze task extracts. The technique developed was adapted from that used within the CHATTS Project [Ogborn, Brosnan & Hann 1992]. The responses obtained were used to evaluate the cloze task extracts and to check that the student and teacher questionnaires and interviews covered the full range of responses, attitudes and opinions. Subjects were interviewed informally as they attempted the task. At School 1020 a group of four school students, two of whom were bilingual, attempted the task as part of the pilot study (see 6.2.2). Groups of six teachers and four sixth form students attempted the task at School 1004. A group of twenty student teachers following a one year PGCE secondary science course at the Institute of Education, London University and two groups of twenty students following a four year B Ed course at De Montfort University also attempted the task.

Two of the extracts used for the discussion tasks (diet and kidneys) were the same as those used for the cloze task. The third extract was based on the conservation extract. The first page of the conservation extract is an historical sequence which might influence subjects' ordering of ideas which was one of the features of understanding of interest. Consequently, the extract used comprised the second half of the cloze extract and subsequent material (see Appendix D).

The outcomes from the task were recorded as concept maps. These are diagrams which trace the flow of ideas. The concept maps indicated the subjects' understanding of the text extract studied as a whole. Tape recordings were made at School 1020 of students' conversation as the attempted the conservation version of the discussion task. These tapes were transcribed and reviewed (excerpts from these transcripts are included in Appendix B). In the case of school students, single sex friendship groups of four students, which did not have a dominant member, were used. Groups which were taped were briefed about the purpose of the research and their anonymity within it. They were asked to identify themselves on tape. This procedure was adopted for ease of later transcription and to test the equipment and seating positions. Tapes were made of all their conversation during the discussion task.

Each subject was given a copy of the old edition of the textbook and was asked to read an extract on their own. Members of each group of four subjects were given the same extract to read. Each group of four subjects was then asked to divide into two pairs. Each pair of subjects was given, a copy of the research instrument, a large sheet of paper and some *Post-Its*. The research instrument was a colour photocopy of the extract in question which had been laminated to make it durable. The extract was divided into numbered sections which each contained a single idea. The sections were organised so that they did not carry over the page. Each of the figures and its caption (this included photographs, diagrams and a table of data), was considered as a separate idea from the main, written text. Figure 12.10 on page 151 was made into two sections, the figure and the caption, and the table. This strategy was an arbitrary way to divide up the text into manageable chunks based on the researcher's interpretation of meaning. However, it is pragmatic. An alternative strategy would have been to have let the students divide up the text into ideas. However, the strategy adopted enabled comparison between the data obtained from different groups and reduced the time required for task completion. Subjects were given the opportunity to criticise the way in which the texts were divided up and any criticisms were noted. In order to test the system of sections proposed, the group of PGCE students were invited to divide the extracts up into sections. The schemes which they produced were then compared with the scheme used in the study. There was found to be broad agreement. Two of the extracts included highlighted questions. As in the cloze task, these highlighted questions were not considered to be part of the continuous prose of the text and were left out of the task, but they were left in the extracts as part of the text. Similarly, subheadings and headings were not included in the task. They referred to whole paragraphs and could be confusing. Two extracts included references to text not included in the task (the Chemistry textbook and two of the worksheets).

The pairs were asked to discuss the extract and to consider the main point of each of the numbered sections. They were told to write each of these ideas very briefly on a *Post-It*. One pair of subjects in each group used blue *Post-Its*, the other pair used red

Post-Its. The *Post-Its* were numbered and were stuck on to large sheets of paper. Pairs were told to organise the ideas on the *Post-Its* into the order which made the most sense to them. Any order was allowed, as long as the subjects could justify their arrangement to the researcher. Pairs were then asked to draw concept maps of these arrangements. At the next stage the two pairs reconvened as a group of four. Each group was asked to compare the two arrangements of ideas produced and to come up with a version which all four group members were happy with. This final version of the order of ideas was also recorded as a concept map. All the materials were retained for analysis.

6.3.9 Other research documents

As mentioned in the account of the research, various documents other than research instruments were developed and used during the research. David Wright set the type for the responses booklets which the students used. These were printed in the same typeface as the textbook in three colours. The grids on which the students wrote their responses to the cloze extracts appeared in different orders in the different coloured booklets. The colours were used in rotation. The written *protocol* (see Appendix D, 6.2.3) used for the administration of student questionnaires and cloze tasks was like a script to be read out by the person administering the task. The protocol was based on the instructions for the administration of the Gapadol reading test [McLeod & Anderson 1973]. The instructions used for the discussion task were produced in the form of a *worksheet* (see Appendix D, 6.3.8). The use of the protocol and worksheet ensured that all the subjects attempting each research task were given exactly the same instructions. This consistency and quality control was important considering the three year period of the study and the fact that on some occasions the task was administered by people other than the researcher. *Kitlists* (see Appendix D, 6.2.3) were simple lists of the equipment needed for each of three different types of visit to schools, preliminary visit, questionnaire/cloze task and discussion task. *Procedures* (see Appendix D, 6.2.3) were lists of what to do for each type of visit including reminders concerning such matters as the documents required and the people who should be seen. Notes on the coding of responses were kept in *directories of responses*. In the case of the cloze data these were lists of incorrect responses and notes on grammar and other features of text connected with the deletions. In the case of the questionnaire data they were notes on the codings given to specific responses. The data were analysed using suites of nested spreadsheets in Framework 2 software. A computer spreadsheet was also used to keep track of correspondence with participating schools.

6.4 Summary

The chapter set out the methods and strategies used in the study. Each of the techniques used was tested for validity through a thorough literature search, discussion with colleagues, and a pilot study. Reliability was checked through triangulation between data sets and through discussions with colleagues. Methodologies were reviewed after the pilot study and adapted in the light of students' comment, teachers' suggestions and operational insights. However, from then on methodologies were left unchanged and procedures were put into place to ensure consistency and to assist in the quality control of data collection. One recurrent theme in the chapter was the need to ensure consistency, reliability and quality control in data collection over a long period of data collection including long gaps between bouts of data collection. The documents and procedures which were developed to give the study a structure and which were used by the researcher were as important to the successful completion of the study as the more public, more professionally produced, research instruments and other documents used with students. The next chapter shows how the data collected using these methods were analysed.

Chapter 7: Analysis and findings

7.1 Introduction

This analysis of the data collected during the research study is divided into three sections. The first part of the chapter comprises an analysis of the students' and teachers' questionnaire data. A general discussion of factors affecting the accessibility of the textbook studied provides a context for a discussion of the effects of bilingualism. In terms of the research agenda set out in Chapter 4 (see 4.2), this is an analysis of classroom contexts which should be considered in the light of the institutional environments described in the school profiles (see Appendix A) and the national context described in Chapter 5. The numbers of bilingual students in the schools studied were such that data concerning bilingual students were collated to create whole-school bilingual subsamples. The demonstration of consistency in the questionnaire data between classes in these schools justifies this collation of data and data sets are presented on a class by class basis in order to facilitate comparisons. The second part of the chapter comprises an analysis of data collected through the cloze task administered to students. In terms of the research agenda set out in Chapter 4 (see 4.2), this is an analysis of *language accessibility* which should be considered against a background of institutional environments and classroom contexts provided by the school profiles and the questionnaire data analysis. The cloze task data satisfy some of the drawbacks found in the questionnaire data. However, any conclusions drawn from the cloze task evidence rely on the background information and justification for collation derived from the questionnaire and school profile evidence. These data sets are thus complementary. The final part of the chapter deals with student interviews which were designed to test the main inferences derived from the questionnaire and cloze task data analysis.

7.2 The samples and bilingual subsamples

The sample is discussed in detail in Chapter 6 (see 6.2.6) and is summarised as Table 6.1. Data from pilot and trial studies were included in the analysis where appropriate. The main sample excluded pilot and trial run data from schools using the textbook studied with students of all abilities but included these data in situations where the sample was relatively homogeneous as explained in Chapter 6 (see 6.2.5). When the analysis involved all the students in a year group who followed the Nuffield Co-ordinated Sciences course, the pilot and trial run data were excluded from the analysis except in the cases of two schools where the data comprised small samples of similar classes. The effects of bilingualism are an important aspect of the research questions discussed in Chapter 4 (see 4.2) and the issues arising from them. Bilingualism is likely to be an important feature of the school culture in Schools 1004, 1018, 1020, 1021, 1031 & 1036 where more than 10% of the students are bilingual. Throughout the analysis these schools will be marked with an asterisk *. Schools 1018*, 1020*, 1021* and 1031* belong to the second and third groups of schools described in Chapter 6 (see 6.2) i.e. they are selective schools or schools where selected classes of more able students follow the Nuffield Co-ordinated Sciences course. Consequently, the samples of students from these schools are relatively homogeneous in terms of ability in science. School 1036* is oversubscribed and has a strict code of conduct. Students who fail to conform are expelled. The school population may thus be fairly homogeneous. The school population at School 1004* is homogeneous in terms of background and parental support. The students' parents have similar high powered careers in international business and diplomacy. It is less homogeneous in terms of ability in science. Data concerning bilingual students for each of these six schools were collated on the assumption that the school populations are relatively consistent.

As explained in Chapter 6 (see 6.2.6), the textbook studied is biased towards students of average and above average ability in science. The sample of schools studied, in particular those schools with more than 10% bilingual students, reflect this bias. The schools using the textbook with students of all abilities in this group (1036* & 1004*) provided small samples of bilingual students (18 & 24). Consequently, the study does not include many bilingual students of limited academic ability or those who are just beginning to acquire English. Schools providing for many such students did not respond to the initial enquiry concerning the research and may not in fact use the textbook studied. Teachers in Schools 1018* and 1020* which have large bilingual contingents had decided to stop using the textbook with students of average and below average ability. These findings might indicate that this textbook is unsuitable for use with bilingual students in language acquisition. Although there are no data concerning these students directly, one might infer that the review presented in Chapter 5 covers the features of science textbooks which they might find difficult.

The schools with more than 10% bilingual students constitute half (6) of the schools studied and include the full range of types of schools studied (i.e. schools where students of all abilities use the textbook, 1004* & 1036*, schools where selected classes of higher ability use the textbook, 1018* & 1020*, and selective schools, 1021* & 1031*). This group of schools also included the only two boys schools studied (1021* & 1031*). All the other schools were coeducational. Some data concerning the bilingual subsamples are presented as Table 7.1. Separate data concerning Gujarati speakers are presented in Table 7.1. Gujarati was the commonest second language found in the schools studied.

Table 7.1: Bilingual subsample data

School Number	Boys n=	Girls n=	Total n=	% of original sample	Languages spoken in addition to English	% original sample Gujarati speakers
1004*	9	15	24	32.4	18	5.4
1018*	24	40	64	86.5	4	78.4
1020*	22	24	46	45.1	16	31.4
1021*	43		43	32.3	21	0.8
1031*	30		30	18.2	17	0.6
1036*	8	10	18	10.5	9	0.0

In terms of gender balance, the bilingual subsample from School 1018* (24 boys : 40 girls) is representative of the main sample (29 boys : 45 girls). However, it is not representative of the school population as a whole, or consistent with the monolingual subsample (5 boys : 5 girls). The main sample is 86.5% bilingual whereas the whole-school population is 95% bilingual (see Appendix A). This gender imbalance may thus be connected with bilingualism. Perhaps able bilingual boys do not achieve in science in this school. However, the sexes were balanced in three other bilingual subsamples. This question was not pursued any further due to insufficient data, as two of these six schools (1021* and 1031*), catering for 73 out of 225 (32%) bilingual students studied, are single sex boys' schools. None of the schools studied is a single sex girls' school.

7.3 Questionnaire data analysis

The questionnaire administered to students as described in Chapter 6 (see 6.2.3, 6.3.1, see Appendix D) was presented in three parts. The first part included identifiers and a question about gender. The next part comprised open-ended questions inviting extended responses from students about their liking for, and attitudes to, the textbook studied. Students were asked to identify sections of the textbook studied which they had found helpful and those which had been difficult, and to suggest possible improvements to the textbook. Students were also asked to state the languages which they used at school and at home. The final part of the questionnaire consisted of four multiple choice questions concerning the use of the textbook. A similar teachers' questionnaire included additional questions about classroom presentation.

7.3.1 Coding the questionnaire data

The questionnaire data collected from the pilot study were plotted onto class data charts in preparation for designing spreadsheets to deal with the main study data. The data from each student's responses were coded onto these charts manually. These charts were then used to design a computer spreadsheet template for use with the data collected from each class participating in the main research study. The charts enabled codings derived from student responses to be worked out. All the final codings were listed in a directory of responses. Comments about the textbook studied, recorded as from favourable, unfavourable and improvements viewpoints, were reviewed and coded under eleven headings derived from the data;

Enjoyment and interest,
A lot of information,
Questions and answers,
Glossary and index,
Page layout and typography,
Understanding and explanation,
Less information,
Language,
Text organisation,
Figures
and Other.

Languages spoken and references to textbook sections were coded. The data from each class were entered into separate spreadsheet templates. Further spreadsheets were written which could lift data from these spreadsheets, manipulate them and present them in a form suitable for analysis. The spreadsheets and data entry were checked manually, and by computer using check columns and test data.

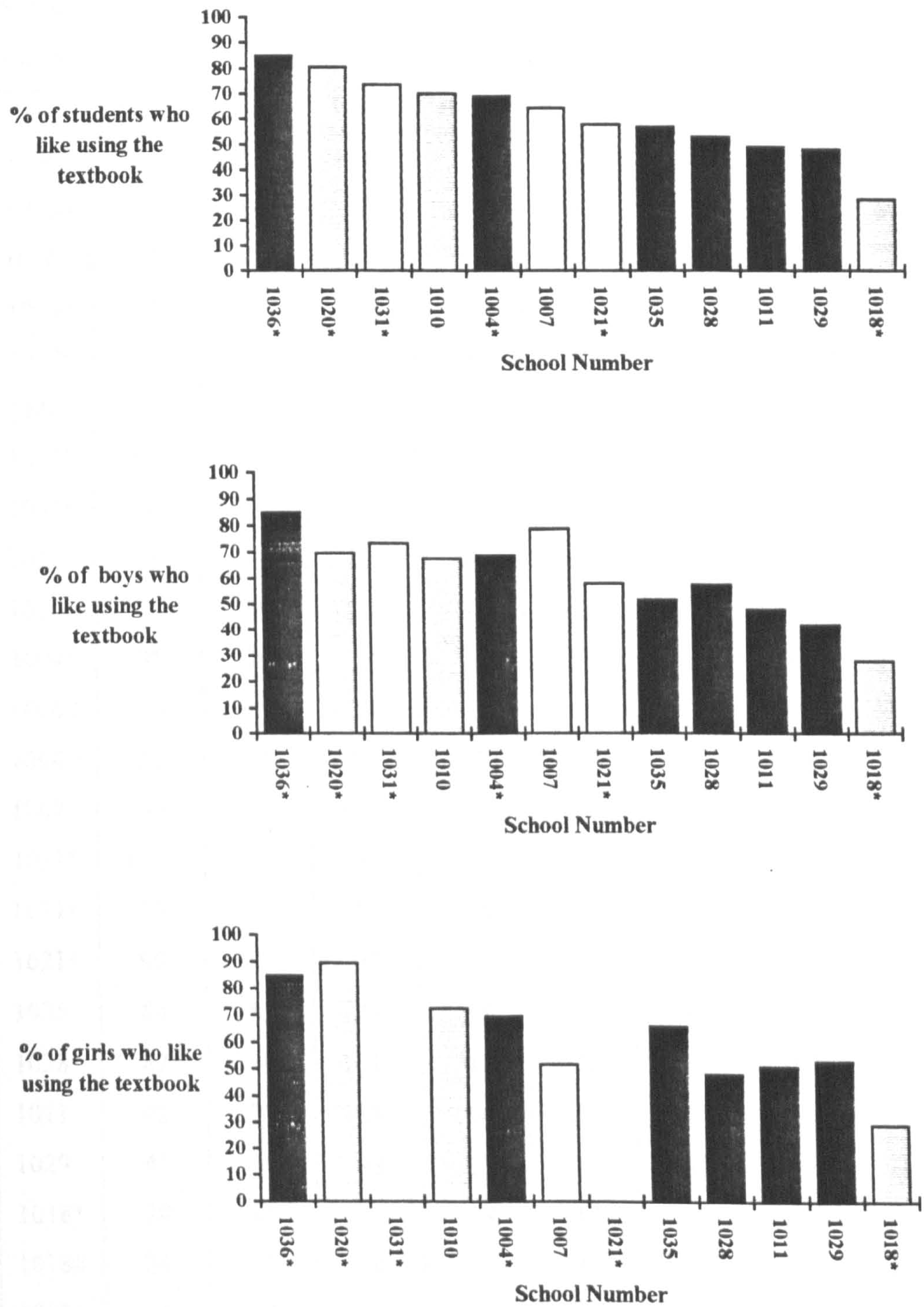
7.3.2 Student views

Students' liking for, or dislike of, a textbook can be considered to be a general indicator of accessibility. In terms of the research agenda set out in Chapter 4 (see 4.2) student approval or disapproval summarises the student's evaluation of institutional environment, classroom context and textbook language accessibility. Bilingual and monolingual students' attitudes were compared. Students' views reflect their assessment of the textbook features described in Chapters 2-5 and their personal priorities which may be affected by cultural or language differences. Language factors and issues concerning the use of textbooks which contribute to students' views are dealt with in the next part of the analysis . Data concerning students' views of the textbook studied were obtained through their responses to the question "*Do you like using the Nuffield Co-ordinated Sciences Biology book?*". The responses were categorised as follows;

those students who liked using the textbook,
those who disliked using it,
those who were undecided
and those who left the space blank.

Overall, 62.5% (950) of the 1520 students who responded to the questionnaire stated that they liked using the textbook, 24.0% (364) disliked it, 12.4% (189) were undecided and only 1.1% (17) did not respond. The data for student approval of the textbook are presented as Fig 7.1 and Table 7.2. The full data are included as Table 7.a in Appendix E. The data are presented on a school by school basis in descending order from the school where the textbook was most popular. This form of presentation enables easy comparison between schools where the popularity of the textbook studied was similar. The data are broken down by gender to facilitate the examination of differences between boys' and girls' assessment of the textbook. The schools with more than 10% bilingual students, 1004*, 1018*, 1020*, 1021*, 1031* and 1036*, are five of the top seven schools and the last school in the order of student approval.

Fig 7.1: Student approval



Key: All-ability schools where all students use the textbook

Selected classes within all-ability schools

Selective schools

*(Schools with more than 10% bilingual students are marked *)*

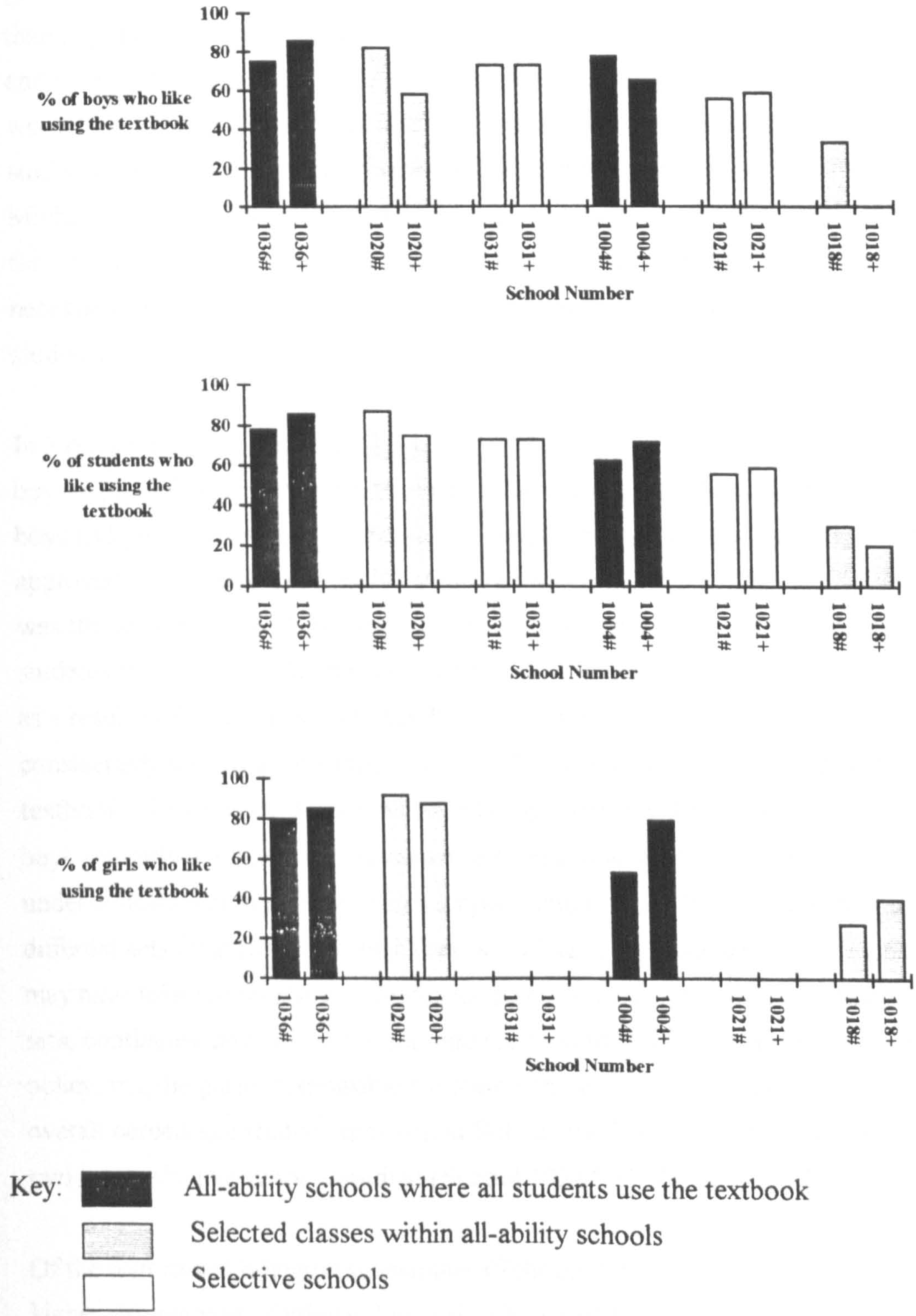
Table 7.2: Student approval

School Number	Total Number of Students			Number of Students who like using the textbook			% of Students who like using the textbook		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
1036*	86	85	171	73	72	145	84.9	84.7	84.8
1036#	8	10	18	6	8	14	75.0	80.0	77.8
1036+	78	75	153	67	64	131	85.9	85.3	85.6
1020*	46	56	102	32	50	82	69.6	89.3	80.4
1020#	22	24	46	18	22	40	81.8	91.7	87.0
1020+	24	32	56	14	28	42	58.3	87.5	75.0
1031*	165		165	121		121	73.3		73.3
1031#	30		30	22		22	73.3		73.3
1031+	135		135	99		99	73.3		73.3
1010	55	58	113	37	42	79	67.3	72.4	69.9
1004*	35	39	74	24	27	51	68.6	69.2	68.9
1004#	9	15	24	7	8	15	77.8	53.3	62.5
1004+	26	24	50	17	19	36	65.4	79.2	72.0
1007	65	70	135	51	36	87	78.5	51.4	64.4
1021*	133		133	77		77	57.9		57.9
1021#	43		43	24		24	55.8		55.8
1021+	90		90	53		53	58.9		58.9
1035	84	55	139	43	36	79	51.2	65.5	56.8
1028	82	69	151	47	33	80	57.3	47.8	53.0
1011	92	73	165	44	37	81	47.8	50.7	49.1
1029	41	57	98	17	30	47	41.5	52.6	48.0
1018*	29	45	74	8	13	21	27.6	28.9	28.4
1018#	24	40	64	8	11	19	33.3	27.5	29.7
1018+	5	5	10	0	2	2	0.0	40.0	20.0

(Bilingual subsamples are marked #, monolingual subsamples are marked +, Schools 1021 and 1031* are single sex boys' schools)*

Data from Table 7.2 concerning bilingual and monolingual subsamples from these schools are presented as Fig 7.2.

Fig 7.2: Breakdown of student approval in schools with more than 10% bilingual students



(Bilingual subsamples are marked #, Monolingual subsamples are marked +)

Gender is an important classroom context issue in this research. First, there is the research evidence discussed in Chapters 2 and 3 (see 2.3.3, 3.4.2) [White 1991 p. 185, Watts & Bentley 1994] which suggested a general link between gender and the accessibility of school science textbooks. Those research findings suggested that girls find school science textbooks less accessible, less enjoyable and less interesting than boys do. Secondly, gender is an issue in the context of bilingualism. As Gilborn and Gipps [1996 p. 57] point out, negative stereotypes, particularly of young Asian women can lead to low expectations on the part of teachers and underachievement in students. Asian girls may be "*systematically ignored or forgotten*" [see also Brah & Minhas 1985]. A textbook may reinforce or counteract such teacher attitudes and this reaction may be reflected in student approval. In this research study it is necessary to tease apart these two effects of gender on student approval in bilingual students.

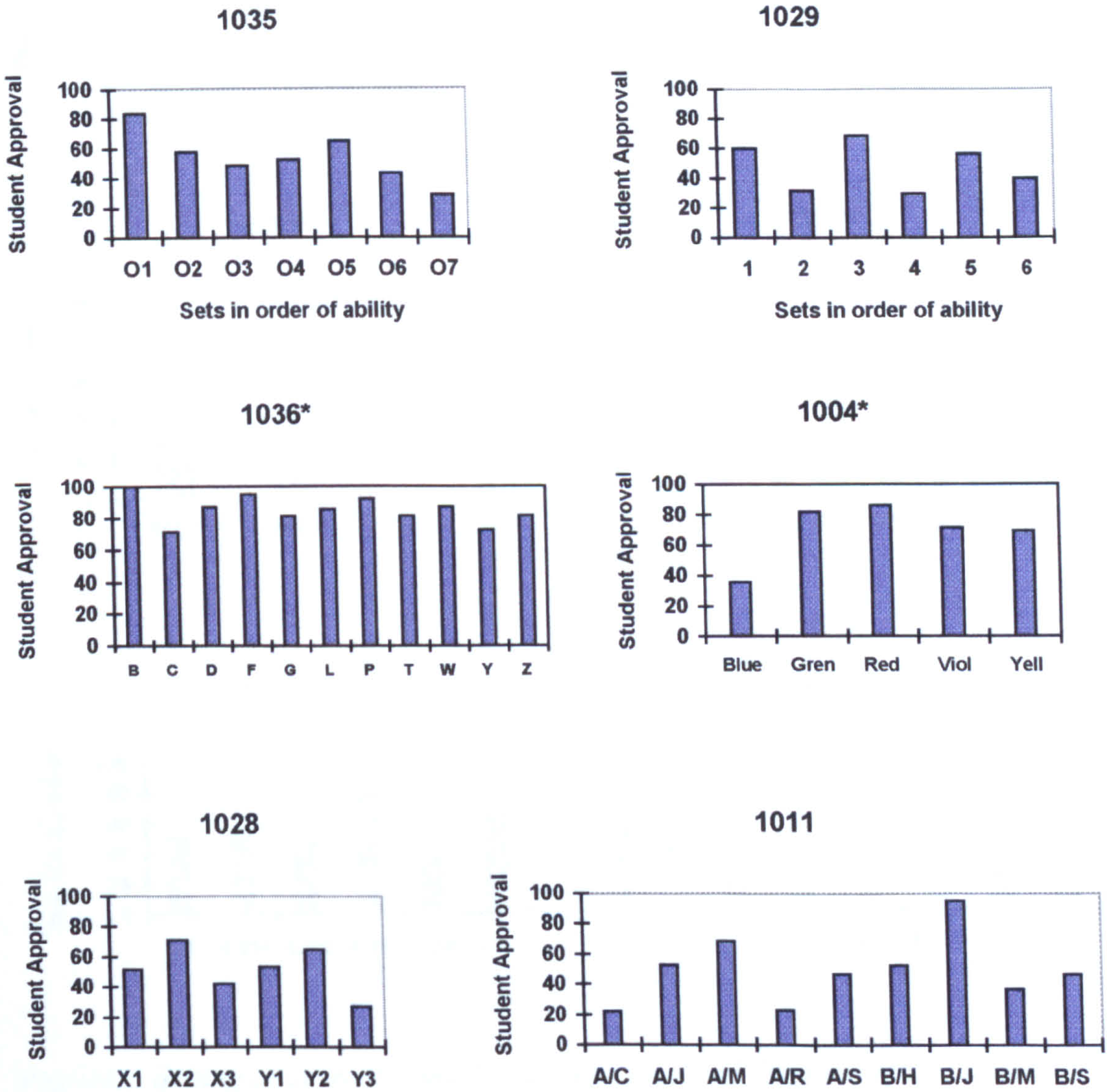
In 7 out of the 10 coeducational schools investigated, higher percentages of girls than boys approved of the textbook studied. In an eighth (1036*), similar percentages of boys and girls approved of the textbook. Higher percentages of boys than girls approved of the textbook in only two mixed schools (1007 & 1028). School 1028 was the subject of the Ofsted report mentioned in Chapter 5 (see 5.2.6). Several students in this school commented that they had become disaffected with the textbook as a result of the way in which they had been expected to use it. At School 1007 a considerably greater percentage of boys (78.5%) than girls (51.4%) approved of the textbook. This school, a grammar school, operated a policy of balancing numbers of boys and girls in science sets in response to past concerns about girls' underachievement in science. Such a policy might result in girls being placed in different sets from those in which they would have been placed on merit alone and may have affected teachers' attitudes to girls in certain sets. Girls' misplacement in sets, continuing underachievement, and reaction to teachers' attitudes to the setting policy, may be partly responsible for their attitude to the textbook. However, the overall percentage student approval at School 1007 (64.4%) was comparable with two boys selective schools studied (School 1021* 57.9%, at School 1031* 73.3%).

Of the four mixed bilingual subsamples (Schools 1004*, 1018*, 1020*, 1036*) higher percentages of bilingual girls than bilingual boys approved of the textbook studied in Schools 1020* and 1036* and a lower percentage of bilingual girls than bilingual boys approved of it in Schools 1004* and 1018*. Each pair of schools includes a school catering for students of all abilities (Schools 1004* & 1036*) and a school where only selected students used the textbook (Schools 1020* & 1018*).

Three types of school were studied, those where the textbook studied was used with students across the full ability range, selective schools like grammar schools and those where it was used with selected groups of students of higher ability. Generally, in schools where the textbook was used across the full ability range, students were less likely to like it and in schools where it was used with selected students and selective schools, they were more likely to like it. This suggests that the textbook provides for a limited range of higher ability students. This finding is further evidence for the bias reported in section 7.2 and Chapter 6 (see 6.2.6). In schools with more than 10% bilingual students where the textbook is used with students of all abilities (1004* & 1036*), monolingual students were more likely to approve of it than bilingual students. In schools with more than 10% bilingual students where selected classes use the textbook (1020* & 1018*), bilingual students were more likely to approve of the textbook than monolingual students. In selective schools with more than 10% bilingual students (1021* & 1031*) opinions are similar in the two groups of students.

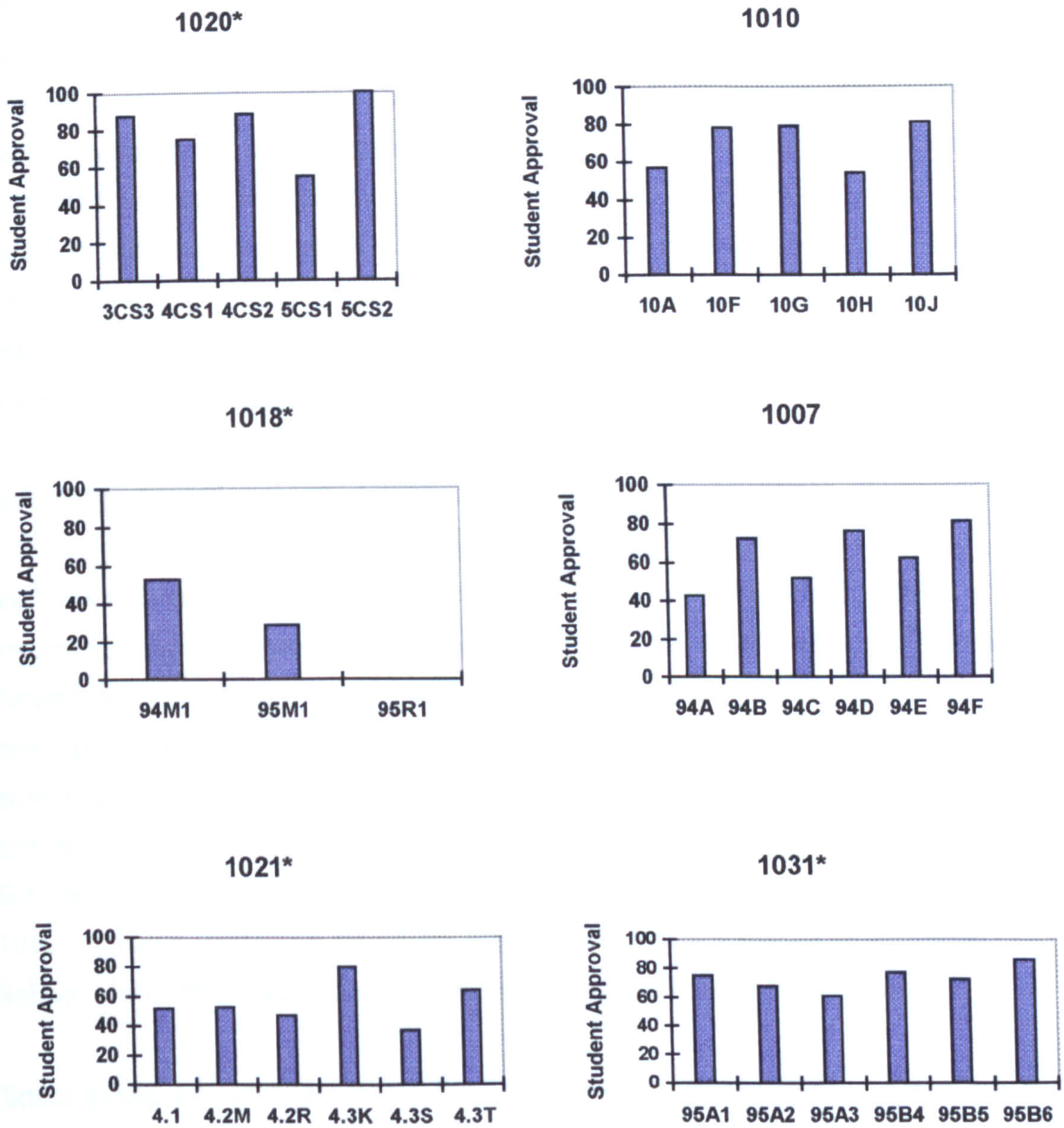
These findings led to an investigation of the effects of setting and student ability on percentage student approval. These are classroom context issues within the research agenda set out in Chapter 4 (see 4.2). Gilborn and Gipps [1996 p. 40] report research [Eggleston et al 1986, Tomlinson 1987, CRE 1992, Gilborn 1990, Troyna & Siraj-Blatchford 1993, Wright 1986] which shows that setting and other forms of internal selection often disadvantages ethnic minority students. The course of which the textbook studied is a part, is intended to cater for students of a wide range of ability (National Curriculum levels 4 to 10). However, as explained in Chapter 6 (see 6.2.6), the textbook may be biased towards able students. Further evidence concerning the difficulties which students of lower ability may have with the textbook is reported in Chapter 5 (see 5.2.6). When comparing data from several schools it was important to identify comparable groups of students with whom use of the textbook was appropriate. It was thus appropriate to compare student approval in groups of different abilities. There was considerable diversity in setting and selection patterns in the schools studied (see Appendix A, Chapter 6: 6.2.6). Fig 7.3 presents the percentage student approval in classes in schools with different school populations and setting arrangements. The full data are presented as Table 7.b in Appendix E.

Fig 7.3: A comparison of percentage student approval between groups in schools operating various setting regimes



Regimes. Continuous setting solely on ability in science in all - ability schools (1035 {n= 139} & 1029 {n= 98}). Discontinuous setting in all - ability schools on various criteria (1036 {n= 171}, 1004* {n= 74} , 1011 {n= 165}). Continuous setting (sets X1, X2, X3 in one half year and sets Y1, Y2, Y3 in the other half year - each in order of ability on various criteria) in an all - ability school (1028 {n= 158}). An asterisk * indicates schools with more than 10% bilingual students.*

Figure 7.3 continued



Regimes. Setting as several "equal" selected classes of "higher ability" in all - ability schools (1010 {n= 113}, 1018 {n= 74}, 1020* {n= 102}, NB data from 1018 and 1020 were collected over more than one year). Setting in equal classes within three bands (4.1, 4.2, 4.3) in a selective school (1021* {n= 113}). Continuous setting within two bands (sets A1, A2, A3 in the higher band and sets B4, B5, B6 in the lower band - each in order of ability) in a selective school (1031* {n= 142}). Continuous setting in a selective school (1007 {n= 110). An asterisk * indicates schools with more than 10% bilingual students.*

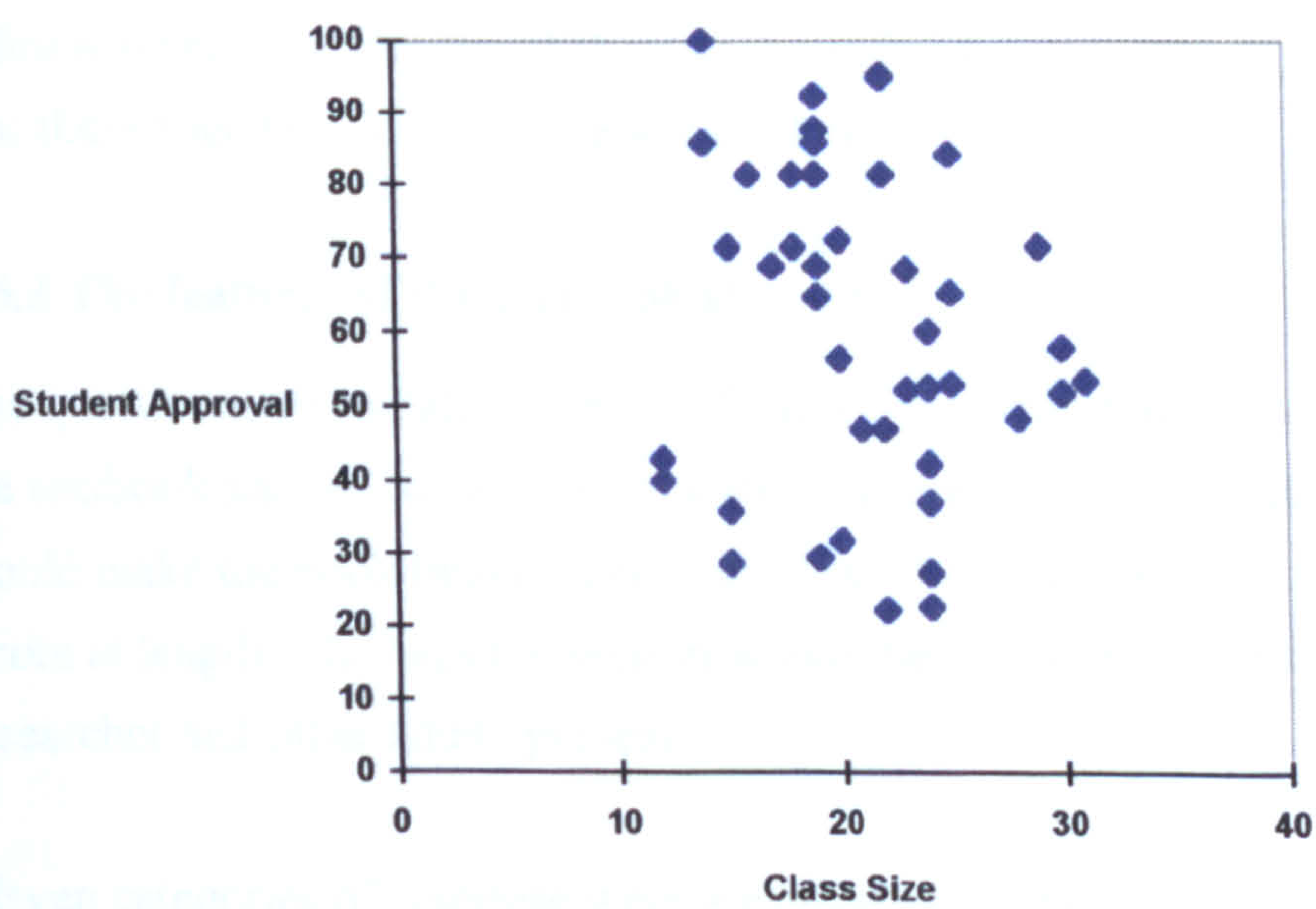
A majority of students approved of the textbook in 70% (31) of classes in schools where students of all abilities use the textbook and 86% (30) of selected classes and classes in selective schools. In Schools 1035 and 1029 students were set in science across the year group solely on ability in science as indicated by test results and teacher recommendation. There is a clear pattern in percentage student approval from most to least able students (see Fig 7.3). School 1028, where half years were setted on various criteria, reflects this pattern to some extent. Percentage student approval in selective schools (1021* and 1031*) reflects that in the corresponding sets in schools with selected classes 1010, 1020* and 1018* and the higher ability sets in schools using the textbook studied with students of all abilities 1035, 1029 & 1028.

Percentage student approval is generally consistent across classes within the schools with more than 10% bilingual students. A majority of students approve of the textbook studied in 34 (90%) of these classes. It is impressive that the high percentage student approval at School 1036* is consistent across the ability range. Percentage student approval is also generally quite high at School 1004*. In both cases, percentage student approval is generally higher than at the comparable, mainly monolingual, School 1011. Schools 1018* and 1020*, are comparable with, the mainly monolingual, School 1010. Percentage student approval is generally lower at School 1018* than at School 1010 and slightly higher at School 1020* that at School 1010. Schools 1021* and 1031* are comparable with, the mainly monolingual, School 1007. Percentage student approval is similar in these three schools.

Some special school students (see 7.5.5, Appendix A School 1009), some of whom had considerable learning difficulties, also completed questionnaires. They generally liked the textbook. However, they were taught in very small classes. It was also noted that in some schools (1011, 1028, 1029 & 1035) it was Science Department policy to make classes known to include students of less ability in science smaller than those known to include more able students. In some cases this decision had been taken on educational grounds. In the interests of finding comparable samples from several schools, these findings led to a study of the effect of class size on student approval of the textbook. In a small class, where adult help is readily available, the textbook may be more effective. Some bilingual students may encounter similar difficulties to those experienced by the special school students and thus small class size may be particularly advantageous to them. In terms of the research agenda set out in Chapter 4 (see 4.2) this is a classroom context issue. The effect of class size on the quality of education is currently a controversial issue in education in the UK which has been taken up by politicians, teachers' representatives and Ofsted [see Dean 1996].

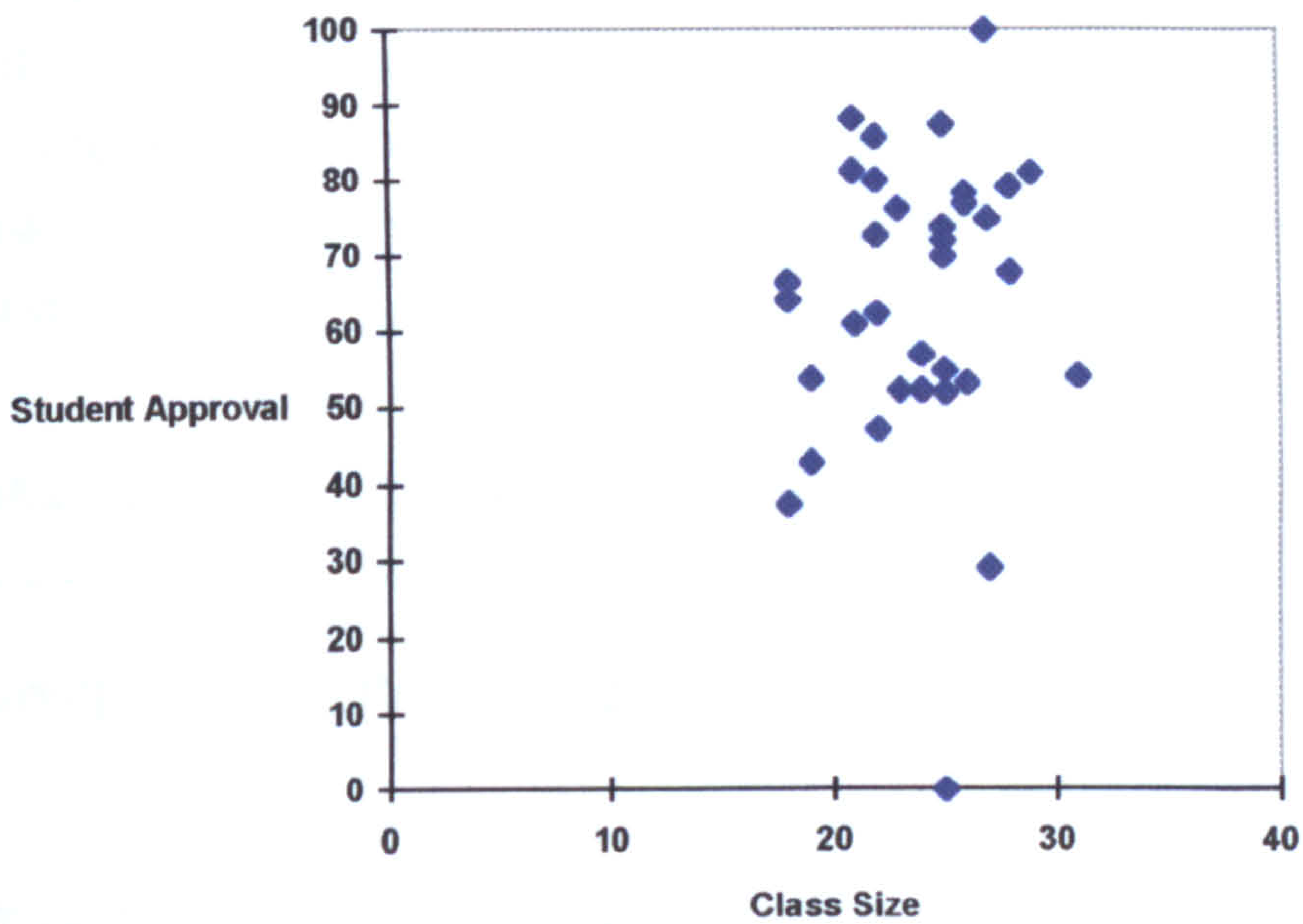
Class size was measured as the number of students on the class register. Classes in schools where students of all abilities use the textbook studied included both the largest (31), and the smallest (12), classes investigated. The schools with more than 10% bilingual students included the schools with the smallest classes (1004* & 1036*) both of which had high percentages of student approval in most classes. The effect of class size on percentage student approval was investigated by plotting a graph of students on register against percentage student approval for classes in schools where students of all abilities use the textbook. These data were taken from Table 7.b in Appendix E and are presented as Figure 7.4.

Figure 7.4: Scatterplot of percentage student approval against class size for classes in schools where students of all abilities use the textbook studied



A linear regression analysis of these data demonstrated a correlation between class size and percentage student approval of -0.2 indicating that there is no significant relationship between these variables. In order to test whether this finding had been affected by the practice reported above, of making classes for less able children small, a graph was also plotted of students on register against percentage student approval for selected classes of higher ability and classes in selective schools. These data were also taken from Table 7.b in Appendix E and are presented as Figure 7.5.

Figure 7.5: Scatterplot of percentage student approval against class size for selected classes of students of higher ability and classes in selective schools



A linear regression analysis of these data yielded a correlation of 0.1, also indicating that there was no significant relationship between the variables.

7.3.3 The features of the textbook studied

The questionnaire included a series of questions concerning students' opinions about the textbook studied, which sections were helpful, which were difficult and what would make the book better. These were open-ended questions where students wrote at length. This was the section where they recorded observations made to the researcher and other adults present.

Eleven categories of response were identified from the pilot study data (see 7.3.1) from three viewpoints *favourable*, *unfavourable* and *improvements*. They arose from consideration of the data charts described in section 7.3.1 and other data including interviews with students and teachers and teachers' questionnaires. The eleven categories were sorted into five groups. *Enjoyment and interest* and *Understanding and explanation* are general responses. *Language*, *Glossary and index*, *Text* *organisation*, *Page layout and typography*, and *Figures*, deal with language and communication of content. *A lot of information*, and *Less information* are concerned with the subject narrative and *Questions and answers* with the teaching discourse of the textbook. The category *Other* included responses covering a wide range of matters which did not fit in any of the other categories, for example "*The book fits in my bag*". The assignment of categories to groups is presented as Table 7.3. In terms of the research agenda set out in Chapter 4 (see 4.2), language and communication relate to language accessibility. Subject narrative and teaching discourse relate to classroom context. General responses, like student approval, summarise research issues.

Table 7.3: The grouping of eleven data categories

Group	**Data coding**	**Links with**	**Total number of responses**
General	Enjoyment & Interest Understanding & Explanation	Student Approval	1855
Language & Communication	Language Glossary & index Text organisation Page layout & typography Figures	Science textbook genre including teaching discourse Science register	1676
Subject narrative	A lot of information Less information	Science register	453
Teaching discourse	Questions & Answers	Science textbook genre	322
Other	Other	Various	603

The general comments were found to be consistent with the responses reported in Table 7.2 and were not analysed any further. Data concerning responses about the subject narrative and teaching discourse, which are comments about the content of the textbook studied, are included as Tables 7.c and 7.d in Appendix E.

The data concerning helpful and difficult sections of the textbook studied (columns MHS and MDS of Table 7.c) were compiled from student responses to the questions "*Which sections helped you a lot?*" and "*Which sections were difficult?*". The topics concerned are listed at the foot of Table 7.c. The data concerning helpful and difficult sections of the textbook provide only a limited insight because teachers use textbooks in different ways and approach topics in different orders. Sections 7.3.4 and 7.4.3 explain how book availability and frequency of use also have an impact on textbook use. Students half way through a course should have covered about half of the material in a textbook but will not necessarily have all covered the same half. Presenting the data class by class takes account of this variation.

In 30% (24) of classes, the commonest response was that no sections of the textbook studied were helpful or remembered. However, sections on the Body, Photosynthesis, Digestion and Diet had proved helpful elsewhere. In half of the classes (39), the commonest response concerning difficult sections was "*none*" or "*not remembered*". The commonest response that "*all the sections were difficult*", was recorded in less than 4% (3) of classes. Sections of the textbook studied on Photosynthesis and Transport around organisms had proved difficult in some classes. Of the three sections used as material for the cloze task, one was considered helpful by 10% (diet 9) of classes and the other two were considered difficult in a few classes (kidneys 1 and conservation 4). Responses from schools with more than 10% bilingual students generally reflect these trends. As students encountered the questionnaire before attempting the cloze task these responses were not affected by that task. Table 6.6 in Chapter 6 (see 6.3.5) presents data which shows that the students were most familiar with the diet extract and least familiar with the conservation extract.

Nil responses to direct questions signify passive acceptance. The commitment implicit in a suggested improvement, makes this aspect of the data relatively important. The first four questions on the questionnaire,

"*Do you like using the Nuffield Co-ordinated Sciences Biology book?*",
"*Why do you think like that about it?*",
"*Which sections helped you a lot?*"
and "*Which sections were difficult?*",
build up to the question, "*What would make the book better?*".

They provide a framework designed to help students think about the textbook studied.

In 73% (58) of classrooms less than 20% of students suggested improvements to the subject narrative of the textbook studied. In a third of classrooms (27), no students made favourable comments about the subject narrative of the textbook. The classes with higher proportions of students suggesting improvements to the subject narrative of the textbook tend to be selected classes of students of higher ability and classes in selective schools. Generally these students commented that they required a textbook which accessed the higher grades at GCSE. Unfavourable comments about the subject narrative of the textbook were also concentrated in these schools. In three quarters of the classrooms studied (61), less than 15% of the students put forward improvements to the teaching discourse. In the schools with more than 10% bilingual students there tended to be more dissatisfaction with the subject narrative than in the overall sample, but opinions on the teaching discourse reflected the findings reported above.

Data concerning responses about language and communication, which are comments about the transmission of the content through various semiotic forms, are presented as Table 7.e in Appendix E. The numbers of bilingual students and numbers of languages spoken were compiled from students' responses to the question

"*Which languages do you speak at home?*".

The data presentation enables comparisons between classes of the effect of bilingualism, measured by either parameter, on the extent of language and communication comments.

More students suggested improvements to language and communication than to subject narrative or teaching discourse. Generally, fewer students made unfavourable comments than made favourable comments, with large proportions suggesting improvements. In over three quarters of the classrooms studied (61), 50% or more of the students suggested improvements to language and communication. These findings are reflected in the data from the schools with more than 10% bilingual students. Data concerning improvements to language and communication, subject narrative and teaching discourse suggested by monolingual and bilingual subsample students in schools with more than 10% bilingual students are presented as Table 7.4.

Table 7.4: Subsamples, language and communication, subject narrative and teaching discourse

Sch No	Language & Communication				Subject Narrative				Teaching Discourse			
	MS		BS		MS		BS		MS		BS	
	n=	%	n=	%	n=	%	n=	%	n=	%	n=	%
1004*	33	66.0	9	37.5	11	22.0	4	16.7	5	10.0	1	4.2
1036*	80	52.3	13	72.2	19	12.4	2	11.1	13	8.5	3	16.7
1018*	4	40.0	49	76.6	1	10.0	7	10.9	0	0.0	0	0.0
1020*	37	66.1	21	45.7	16	28.6	17	37.0	3	5.4	1	2.2
1021*	67	74.4	30	69.8	27	30.0	12	27.9	17	18.9	5	11.6
1031*	86	66.2	16	53.3	36	27.7	13	43.3	18	13.8	4	13.3

(MS = Monolingual Subsample, BS = Bilingual Subsample)

The most frequent comments were made by students under the language and communication heading. Although there were some large differences between responses from monolingual and bilingual subsamples, there is no pattern in these data. Responses concerning subject discourse are similar for monolingual and bilingual subsamples. Numbers of responses on teaching discourse from both monolingual and bilingual subsamples were relatively small and were discounted. The findings concerning language and communication were investigated further. The data concerning language and communication broken down to the five constituent categories and summarised on a school by school basis, are presented as Table 7.5.

Table 7.5: Student judgements about improvements to language and communication categories

Sch No	Total no of stud pres	Language		Glossary & index		Text organisation		Page layout & Typography		Figures	
		n=	%	n=	%	n=	%	n=	%	n=	%
1035	139	15	10.8	14	10.1	29	20.9	2	1.4	39	28.1
1029	98	10	10.2	2	2.0	18	18.4	1	1.0	33	33.7
1036*	171	8	4.7	7	4.1	29	17.0	2	1.2	65	38.0
1036#	18	3	16.7	2	11.1	4	22.2	0	0.0	10	55.6
1036+	153	5	3.3	5	3.3	25	16.3	2	1.3	55	40.0
1004*	74	12	16.2	1	1.4	20	27.0	1	1.4	19	25.7
1004#	24	1	4.2	1	4.2	3	12.5	0	0.0	5	20.8
1004+	50	11	22.0	0	0.0	17	34.0	1	2.0	14	28.0
1028	151	13	8.6	7	4.6	19	12.6	3	2.0	39	25.8
1011	165	23	13.9	1	0.6	32	19.4	3	1.8	63	38.2
1020*	102	12	11.8	10	9.8	14	13.7	2	2.0	30	29.4
1020#	46	4	8.7	7	15.2	4	8.7	0	0.0	11	23.9
1020+	56	8	14.3	3	5.4	10	17.9	2	3.6	19	33.9
1010	113	13	11.5	3	2.7	16	14.2	1	0.9	39	34.5
1018*	74	16	21.6	0	0.0	31	41.9	2	2.7	28	37.8
1018#	64	16	25.0	0	0.0	30	46.9	2	3.1	25	39.1
1018+	10	0	0.0	0	0.0	1	10.0	0	0.0	3	30.0
1007	135	6	4.4	2	1.5	30	22.2	6	4.4	45	33.3
1021*	133	6	4.5	12	9.0	69	51.9	2	1.5	37	27.8
1021#	43	3	7.0	4	9.3	14	32.6	0	0.0	17	39.5
1021+	90	3	3.3	8	8.9	55	61.1	2	2.2	20	22.2
1031*	165	7	4.2	22	13.3	35	21.2	3	1.8	57	34.5
1031#	30	1	3.3	3	10.0	8	26.7	0	0.0	8	26.7
1031+	135	6	4.4	19	14.1	27	20.0	3	2.2	49	36.3
Total	**1520**	**141**	**9.3**	**81**	**5.3**	**342**	**22.5**	**28**	**1.8**	**494**	**32.5**

*(Schools with more than 10% bilingual students marked *,*
bilingual subsamples marked #, monolingual subsamples marked +,
Total no of stud pres = Total number of students present)

Between 25 and 39% of students considered that improvements to the figures were necessary. Page layout and typography were considered in need of improvement by far fewer students. Fewer students suggested improvement to language and glossaries or indexes than suggested improvements to text organisation or figures. The main sample data from the schools with more than 10% bilingual students generally reflect these findings.

The proportion of bilingual students at School 1004* commenting on language is less than a fifth of that of the monolingual students. The proportion of bilingual students commenting on text organisation is about a third of that of monolingual students. The proportion of bilingual students from School 1036* commenting on language matters is four times as great as that of monolingual students and that proposing a glossary or index is nearly four times as much. Generally, a higher proportion of bilingual students than monolingual students commented on language and text organisation matters. At School 1020* a larger proportion of bilingual students than monolingual students commented on the provision of a glossary or index, whereas a larger proportion of monolingual students commented on language, text organisation and figures. At School 1021* the proportion of bilingual students (32%) commenting on text organisation is half that of monolingual students (61%). The proportion of bilingual students at School 1021* commenting on figures was nearly half that of the monolingual students. The proportion of bilingual students at School 1031* commenting on figures is less than that of the monolingual students.

113 (7.4%) students made favourable *other* comments, 227 (14.9%) made unfavourable *other* comments and 266 (17.4%) suggested various *other* improvements. Students had been encouraged to record conversations with the researcher in this open-ended section of the questionnaire as explained in Chapter 6 (see 6.2.3). This practice may have inflated the total of *othe*r comments: however, it provides a valuable insight into students' concerns. Students made a wide range of remarks concerning their teachers, textbooks in general and the other components of the Nuffield Co-ordinated Sciences course. In particular, they mentioned the activities associated with the textbooks. Some remarks concerned pragmatic issues such as the size and weight of the textbook studied, the ease with which one could carry it to and from school and the addition of hard covers. Some students liked the textbook because it had become familiar. Such unsolicited remarks are difficult to analyse,

simply because it is impossible to tell how many other students would have responded if asked about these matters directly. Some other comments such as "*the book is very convenient*", "*I'm easily distracted from it*", "*It's good for revision*", "*It's easy to copy from*", and "*scrap it*" were listed under "other" because their vagueness made them difficult to categorise. Does, "*The book should have more pages*" imply problems with content, type size, figures or something else? "*The book should have colour*" was difficult to interpret because the textbook studied is in full colour.

Favourable other comments about the textbook studied concerned matters such as the *co-ordination of the sciences, covers, referencing, accuracy, usefulness for revision and use at home*. Unfavourable comments concerned the *co-ordination of the sciences, referencing, accuracy, usefulness for revision and irrelevant material*. Suggested improvements to the textbook itself concerned the *co-ordination of the sciences, referencing, usefulness for revision and irrelevant material*. Suggested changes in format included, video, tape CD ROM, Internet laminated pages and conversion into short booklets. These comments were considered in context as the views of a minority of research subjects and were not analysed further. However, it was noted that the co-ordination of the sciences, referencing and usefulness for revision were student concerns.

7.3.4 Using the textbook studied

The way in which a student is instructed to use a textbook and the edition used are classroom context issues within the research agenda set out in Chapter 4 (see 4.2). Differences in the way that groups of students use the textbook studied might affect comparisons in the accessibility of the textbook between subsamples of bilingual and monolingual students in the same school and between groups of bilingual students in different schools. Such differences or similarities are thus of interest to this research study. Variation in teaching style, approaches to differentiated learning and availability of resources occur at the class level. The data concerning type and frequency of use are presented on a class by class basis in order to enable comparisons to be made between the use of the textbook studied in different classes.

Student responses to the question, "*How do you usually use the book?*" are presented as Table 7.f in Appendix E. The columns refer to the multiple choice responses offered to students, i.e. Background Reading, Answering Questions, Making Notes and in another way. These responses reflect, teachers' instructions, students' self directed study and students' attitude towards different forms of activity. There is some consistency within classes, responses being generally quite high or quite low. This consistency is to be expected in groups of students who have each had the same experience. Responses under *other* were limited to less than 15% of students in 75 (95%) of classes, suggesting that the multiple choice responses offered were adequate. The data is analysed further to give insights into the teaching strategies used with different classes in section 7.4.3. The findings for schools with more than 10% bilingual students suggest that these students used the textbook studied in a similar ways to other students.

Data concerning a frequency of use index and responses to the question "*When do you usually use the book?*" are presented as Table 7.g in Appendix E. The information concerning access to the textbook studied is taken from the school profiles included as Appendix A. Both teachers' and students' questionnaires included questions about frequency of use. However, the course was organised in various ways in different schools. Sometimes biology was timetabled for each week, elsewhere it was taught more intensively for blocks of weeks [Kearsey 1995]. Consequently, it is difficult to make an objective analysis of comments on frequency of use. These data were therefore reluctantly discounted. However, students were asked to indicate whether they had previously read the three extracts used as cloze tasks administered with the questionnaires. The frequency of use index was calculated from responses to the question, "*Have you read this section before?*", concerning each of three extracts from the textbook studied administered as cloze tasks. The figure presented is the total number of positive responses for all three extracts, divided by the number of students present, a number between 0 and 3. Table 6.6 in Chapter 6 (see 6.3.5) presents a separate analysis of this data showing which extracts had been previously read in each school. The discussion in section 6.3.5 suggests that students at seven schools, 1004*, 1007, 1020*, 1021*, 1028, 1029 and 1031*, are familiar with the extract on diet whilst those at 1036* are equally familiar with the extract on diet and the extract on kidneys. The extract on conservation was unfamiliar to at least 94% of students in all the schools. The extract on the kidneys was unfamiliar to at least 75% of students in all the schools except School 1036*.

There appeared to be a relationship between the frequency of use and the popularity of the textbook studied in some schools, for instance, the frequency of use index scores were higher in schools where the textbook studied was more popular, and lower in those where it was less popular (e.g. Schools 1018* & 1036*). However, there is no general pattern throughout the data. Although, frequency of use and patterns of use are similar in Schools 1018* and 1010, students at School 1010 generally approved of the textbook whereas those at School 1018* generally disapproved of it. As explained earlier (see 7.3.2, Fig 7.3), students at School 1035 are setted, solely on their ability in science as judged by teacher recommendation and examination results, across entire year groups. These students also enjoy unlimited access to the textbook studied. Table 7.g shows a pattern in the use of the textbook by students in these sets from the most able students (01) who use the textbook both at home and at school to the least able (07) who use the textbook mainly in the classroom. This pattern is reflected in selected classes and to some extent in other classes in schools where students of all abilities use the textbook (Schools 1028, 1036*). The course textbooks were issued to students in five of the six schools with more the 10% bilingual students (1004*, 1020*, 1021*, 1031* and 1036*). Generally in these schools, frequency of use was high (see also 6.3.5) and students used the textbook both in class and at home.

There were insufficient copies of the textbook studied for it to be issued to students in five comprehensive schools and in four schools (1010, 1011, 1018* & 1029), textbook use was mainly limited to the classroom. This practice was strongly criticised in a recent Book Trust Report on the use of books in schools [Book Trust 1996 p. 12]. Classes in these schools generally had a lower frequency of use than comparable classes. However, reference to Table 7.f suggests that, despite this limitation on resources, teachers still managed to employ the full range of learning activities in these schools. This finding reflects a general shortage of textbook resources in British schools discussed in Chapter 5 (see 5.2.1) [HMI 1992 p. 21, Ofsted 1993a p. 19, 1995b p. 17, 1996a paras 240-242, Fisher 1995, Rosenthal 1996, Book Trust 1996]. Textbook use is restricted to the classroom in only one school with more that 10% bilingual students (1018*).

The second edition of the textbook studied was published in 1992 (see Chapter 5: 5.2.3). Differences between the editions are discussed in Chapter 5 (see 5.4.2). As explained in Chapter 6 (see 6.3.4), the old edition of the textbook was used to compile the cloze task administered as part of this research project. Table 7.6 presents data about the editions of the textbook used collected as responses to the question "*Which type of book do you usually use?*".

Table 7.6: Textbook editions

School Number	Access (issued I, or not N)	Number of classes using editions			Number of classes
		New ed	Old ed	Both	
1035	I		2	5	7
1029	N		6		6
1036*	I		4	7	11
1004*	I	5			5
1028	I		4	2	6
1011	N	2		7	9
1020*	I		4	1	5
1010	N			5	5
1018*	N		3		3
1007	I		8		8
1021*	I		1	6	7
1031*	I			7	7
TOTAL		7	32	40	79
%		8.9 %	40.5 %	50.6 %	100 %

School 1004* had taken up the course relatively recently and School 1011 had purchased cheap second-hand copies of the new edition of the textbook studied. The policy at School 1021* which, like School 1004*, is independent, was to *update* textbook stocks within a few years. Students at School 1021* were each issued with an additional, alternative textbook. At another independent school (1019 see Appendix A), a brand new copy of the textbook was issued to each student at the start of the course. 91% of classes studied used the old edition, a finding which provides a further justification for the decision to base the cloze task used on the old edition. The schools with more than 10% bilingual students included one which exclusively used the new edition (1004*) one which exclusively used the old edition (1018*) and four which used both editions (1020*, 1021*, 1031* & 1036*).

7.3.5 Teachers' questionnaire responses

Class teachers' opinions of the textbook studied were investigated through the teachers' questionnaire discussed in Chapter 6 (see 6.3.1, Appendix D). This questionnaire was based on the students' questionnaire with a few modifications such as some additional questions concerning the presentation of activities. Teachers were not asked about the languages they spoke at home but were asked to give additional comments about the textbook. 36 teachers responded, however, some responses were incomplete. As explained in section 7.3.4, the data collected concerning frequency and recent use of the textbook were discounted. Also, the student data concerning teaching strategies was used in preference to the similar data collected from teachers in this questionnaire (see 7.4.3). Consequently, the data reported here are limited. Teachers' questionnaire responses informed the pilot study discussed in Chapter 6 (see 6.2.4) and data coding (see 7.3.1).

Data concerning teachers' approval of the textbook studied were obtained through responses to the question "*Do you like using the Nuffield Co-ordinated Sciences Biology book?*". Teachers in seven schools (1035, 1029, 1036*, 1004*, 1028*, 1007 & 1031*) liked using the textbook, teachers in three schools (1020*, 1010 & 1018*) disliked it and teachers in two schools (1011 & 1021*) were undecided. Teachers in the schools with more than 10% bilingual students (marked with asterisks) were typical of those studied in this respect. The questions "*Why do you think like that about it?*", "*Which sections helped you a lot?*" and "*Which sections were difficult?*", build up to the question, "*What would make the book better?*" (see 7.3.3). Teachers' comments about the textbook are summarised as Table 7.7 and their suggested improvements to it are summarised as Table 7.8.

Table 7.7: Teachers' comments about the textbook studied

Comment	Number of responses
Most suitable for able students	16
Good photographs	15
Colourful	9
Use it for background reading	8
Use diagrams, charts and tables	7
Attractive, clear presentation	7
Useful questions	5
Use it for homeworks	3
Fairly easy to read	2
User friendly	2
Not useful for homework	2
Students don't like it	1
Students find it bulky and heavy	1
Good page layout	1
Students respond to it	1
Use it in tandem with other books	1
Matches Nuffield syllabus	1
Everyday contexts not very good	1
Good coverage of subject	1
Obscure questions	1
Good order of topics	1
Bad order of topics	1
Modern information	1
Useful chapter reviews	1
Better diagrams	1

(Total number of respondents n= 36)

The most common comment about the textbook studied, which was made by 44% of the teachers who responded to the questionnaire, was that the textbook is most suitable for able students. Other common comments concerned the figures and the overall use of colour in the textbook. Teachers commented that they use the textbook particularly for background reading, for the diagrams, charts and tables, and for the questions. None of the teachers commented on the accessibility of the textbook to bilingual students. There was no difference between the pattern of responses from teachers in the schools with more than 10% bilingual students and the pattern of responses from teachers in the other schools.

Table 7.8: Improvements to the textbook studied suggested by teachers

Comment	Number of responses
More detailed information	16
Better questions	11
Review sections at the end of chapters	10
Better written text	9
More relevant information	5
Answers to questions	5
Better text organisation	4
Better diagrams	3
Glossary	2
Better use of colour	2
More colour photographs	1
More diagrams	1
More variety	1

(Total number of respondents n= 36)

The most common suggestion to improve the textbook studied was that it should provide more detailed information. This was suggested by 44% of the teachers who responded to the questionnaire. Improvements to questions, review sections and the written text itself were each suggested by over a quarter of these teachers. None of the teachers suggested improvements to the textbook related to its accessibility to bilingual students. There was no difference between the pattern of responses from teachers in the schools with more than 10% bilingual students and the pattern of responses from teachers in the other schools.

Responses to the question, "*How do you introduce text to your classes when you use it?*" are presented as Table 7.9.

Table 7.9: Text presentation

School Number	Di	SA	KW	NT	RA	BS	None
1035		*	*	*			
1029	*				*		
1036*	*	*	*	*	*	*	
1004*	*	*	*	*	*	*	
1028	*	*	*	*	*		
1011	*		*	*	*	*	
1020*	*				*		
1010	*		*				
1018*	*	*	*	*			
1007	*	*	*	*	*	*	
1021*	*	*			*		
1031*	*	*	*	*		*	
Total	11	8	9	8	8	5	

*(Schools with more than 10% bilingual students marked *. Di = I discuss it with them, SA = summarising activities, KW = we pick out key words, NT = note taking, RA = reading aloud, BS = brainstorming, None = none of these)*

Activities related to the textbook studied were introduced in all the classes studied. Teachers in the schools with more than 10% bilingual students were typical, in their style of presentation of text when using it for classroom activities.

7.4 Discussion of the questionnaire data

A majority of students approved of the textbook studied in three quarters (60) of the classrooms investigated. Student approval varied between 0% and 100% (More than two thirds of the students approved of the textbook in half (40) the classrooms studied and in a quarter of them (19), student approval was over 80%. A majority of students approved of the textbook in 87% (33 out of 38) of classes in schools with more than 10% bilingual students. Although these statistics suggest that the textbook is popular and successful, they give no insight into the relative importance of the factors involved in textbook accessibility. Before the research questions concerning the effects of bilingualism on textbook accessibility can be properly addressed, the questionnaire data should be examined for information about classroom context issues which surround the accessibility of the textbook. The questionnaire evidence will be used to justify the collation of data collected from bilingual students in certain schools and to provide the context against which data appertaining to the research questions will be addressed.

Gender is an issue in the accessibility of science text to bilingual students which was discussed in section 7.3.2 and Chapter 2 (see 2.3.3), in terms of the treatment of female bilingual students in the classroom and gender roles in minority cultures. It is therefore important to examine and assess any potential underlying gender issues surrounding the textbook studied which are not linked with bilingualism. The ability of students in science might affect how accessible they find the textbook studied. Ability in science might imply skill in interpreting the language of science. Ability in science and the criteria used to sort students into groups are thus important issues. Class size might affect the accessibility of a textbook. In smaller classes, struggling students might be more likely to get the help they need in making sense of the textbook. Teaching strategies were discussed as an important aspect of the classroom use of all texts in Chapter 2 (see 2.5-2.5.4) and are thus an important issue in textbook accessibility. The use and availability of resources, which was discussed in Chapter 5 (see 5.2-5.2.6), is an important issue in schools which links with financial and other constraints. Lastly, the book itself should be examined. As discussed in Chapter 5 (see 5.3-5.5), the way it is written and presented is an issue in its general accessibility. Once these issues have been discounted or added to the context of the study it should be possible to address the research questions.

7.4.1 Gender, ability and class size

There is little evidence in the data collected to support White's [1991 p.185] and Watts and Bentley's [1994] concerns about girls' difficulties in accessing science text. However, it should be noted that the textbook studied is a biology textbook and that biology has traditionally appealed to girls more than physics or chemistry. As mentioned in Chapter 2 (see 2.3.3) biology is more issues-based and personal than physics and chemistry. It may not therefore be safe to extend this conclusion to physics or chemistry textbooks. The gender imbalance of the sample at School 1018* (see 7.2) in favour girls might suggest that, in this circumstance at least, bilingual girls are not disadvantaged by cultural differences. However, such findings should be treated with caution. Information was not collected concerning the religion of students, but Gujarat is mainly Hindu [Johnson 1995 p. 205]. Muslim girls and their families might react to science differently. However, the findings suggest that gender is not an important issue within these data as a whole and that there is no need to deal with male and female responses separately. It is also legitimate to compare data from mixed schools with data from single sex schools (Schools 1021*, 1031*) or gender imbalanced samples (Schools 1011, 1018*, 1020*, 1028, 1029, 1035).

In general able students, as judged by the sets or selective schools in which students were placed, were more likely to approve of the textbook studied than less able students. Such an explanation might account for the low percentage approval recorded for some classes (such as 1028 Y3, 1029 4 and 1035 07, all of which are lower sets). Intelligent students may dislike the textbook because it fails to provide them with the information they require in sufficient detail, or in a form which is easy to learn, in order to achieve the higher grades at GCSE. This explanation might account for student disapproval at School 1021* and in 1018* 95M1 and 95R1. One might conclude that groups of students of similar ability in science would find the textbook equally accessible. Whether they found it acceptable would depend upon their aspirations. There were some differences between the data collected from schools with different setting regimes which were possibly linked to the ability of the students concerned. There were also differences between the data collected from schools with more than 10% bilingual students and similar, mainly monolingual, schools. However, these findings were inconclusive. Setting regime may be an issue within this research and should be taken into account when comparing samples and subsamples. It might not be advisable to collate data from students of a wide range of ability, particularly if some students were poorly motivated or disliked the textbook studied. It is reasonable to compare and collate data from classes of similar ability and setting regimes. Class size did not appear to affect student approval of the textbook studied. The implications of this finding is that it is legitimate to compare and collate data from classes of different sizes.

7.4.2 The textbook studied

In the author's opinion, textbooks should challenge students. They are designed for use in classrooms in conjunction with other resources, including the teacher who is available to sort out individual students' difficulties. Textbooks have to cater for students of a broad range of interest, ability in science and background. The data presented in Table 7.c in Appendix E suggest that the material presented in the textbook studied is appropriate for the majority of the students who are expected to use it. It was concluded that the sections chosen as cloze task material were typical of the textbook. There was no evidence to suggest that bilingual students reacted to topics covered in a different way from other students. It was concluded that the textbook and cloze task material were appropriate for these students. Comparisons can be made between the performances of bilingual and monolingual students using the textbook studied in similar circumstances.

The subject narrative is considered to be adequate by most of the students expected to use it. It is debatable whether extra material should be included in the textbook studied in order to satisfy a minority of students who aspire to higher grades at GCSE. These students might be better served by a supplementary or alternative textbook as provided in School 1021*. Reaction to the teaching discourse is loosely linked with the use of the textbook's teaching discourse as a teaching strategy (see Tables 7.11 and 7.d in Appendix E). However, the response was generally low and reached as high as a third of the class in only a few of the classrooms studied. One might conclude that the teaching discourse presented in this textbook is considered adequate by most students. An alternative conclusion might be that students have become resigned to coping with a particular style of textbook and teaching approach. Some bilingual students' criticism of the subject narrative which is dependent on the science register may indicate that they have problems with the science register.

The general trend in the schools setted solely on ability in science (Schools 1029 and 1035) is for higher proportions of students in the lower sets to suggest improvements to the textbook studied in the area of language and communication than in the higher sets. One might infer from these findings that more students of lower ability recognised that they have difficulties with this aspect of the textbook compared with their more able colleagues. However, some students in selected classes of higher ability and classes in selective schools (Schools 1007, 1018*, 1020*, 1021*, 1031*) suggested improvements to the textbook in this area more vigorously than some of these lower ability classes. One could speculate that bilingual students are responsible for the higher proportion of student language concerns in Schools 1018*, 1020*, 1021* & 1031* or that their presence heightens everyone's awareness of language matters. Despite the general student approval of the textbook there is a widespread feeling amongst students that the language and communication aspects could be improved. Dissatisfaction was greatest in classes with bilingual students or students of lower ability in science.

Students (25-38%) consistently criticised the figures in the textbook studied regardless of the proportion of bilingual students in classes. The characteristic form of scientific diagrams is linked to the science register as described in Chapter 3 (see 3.4.1). Other figures support written text through illustration and example and make it more attractive. The organisation of the text was also criticised by students, particularly in schools with substantial proportions of bilingual students (1004*, 1018* & 1021*). Although fewer students commented on language, glossaries and indexes, the biggest responses in each case came from schools with substantial proportions of bilingual students. These findings concerning language may indicate that provision is adequate, that teachers compensate more for shortcomings in this area than in other areas, or that difficulties in this area are less obvious to students. The schools with higher proportions of students making suggestions in these areas have higher proportions of bilingual students than the other schools (Schools 1004*, 1018*, 1020*, 1021*, 1031*) or have classrooms where the textbook is used with students of lower ability in science (School 1035). This finding may be significant.

7.4.3 Teaching strategies and resources

The criteria set out in Table 7.10 were used to interpret the data concerning classroom activities presented as Table 7.f in Appendix E.

Table 7.10: Student responses linked to teaching strategies

Student responses	Teaching strategies
Background reading	As a source of reference to supplement the teacher's subject narrative.
Answering questions	The book assumes part of the teacher's function.
Making notes	As a source of information.
Copying diagrams	As a source of information.
In another way Revision Project work Research Working out what words mean Data Going over it with the teacher Teacher cover Adapting diagrams Learning diagrams Homework Reading for interest Looking at pictures To learn interesting facts Used in conjunction with another textbook To prop up table To lean on	 As a source of reference to supplement the teacher's subject narrative. The book assumes part of the teachers function. As a source of information.

Within the research agenda set out Chapter 4 (see 4.2), teaching strategy is an aspect of classroom context. Student responses were used in the interpretation of teaching strategies in preference to teacher responses given in teacher questionnaires for various reasons. Student responses give a clearer insight into the students' judgements which contributed to their own perception of the accessibility of the textbook. Some students had been taught by various teachers during the course. Student responses take this into account and give a better overview of teaching strategies employed during cover lessons and other unusual circumstances.

Employing a textbook in ways appropriate to specific groups of students is an important part of the teacher's role in education. A teacher may use a textbook as a source of information which informs their own chosen teaching discourse (discussed in Chapter 3, see 3.3.2) and selected teaching and learning activities. Alternatively, a teacher may use a textbook in a way where the book itself assumes much of the teacher's function through its own teaching discourse, integral questions and learning activities. The textbook performs this function in addition to its role as a source of information. This strategy may not necessarily imply an abrogation of responsibilities on the part of the teacher, although students may view it as such. By using the textbook in this way, teachers may free themselves from presenting material in order to guide individual students. It may thus be used as a legitimate means of providing differentiated learning. Lastly, a teacher may use a textbook as a source of reference material for students. Used in this way, the textbook supplements the teacher's own chosen teaching discourse and subject narrative. This kind of teaching strategy helps students to develop the study and referencing skills they may require if they wish to continue their studies beyond GCSE.

These teaching strategies differ in the relative importance of the textbook's teaching discourse and subject narrative (see 7.3.3). Three comparable learning strategies are employed by students. First, the student may treat the textbook as a source of information which contributes to self directed or teacher directed study. Secondly, the student may use the textbook as a study guide or as a substitute teacher as well as a source of information. Thirdly, the student may use the textbook as a source of reference which supplements a subject narrative provided by the teacher or by an alternative textbook. All three learning strategies rely on the subject narrative presented in the textbook. The subject narrative links with language and communication (see 7.3.3) through an understanding of the science register (discussed in Chapter 3, see 3.4, 3.5, 3.6). The second learning strategy relies on the teaching discourse presented in the textbook in addition to the subject narrative. In terms of language and communication it requires an understanding of teaching discourse and the school science textbook genre (discussed in Chapter 3, see 3.3).

Individual students may use these strategies for their own "*independent unsupervised study*" [Thorndike 1917, Bormuth 1969 p. 716, see also Chapter 6: 6.3.5]. Within a programme of teacher-led instruction, the strategies constitute "*supervised instruction*". "*Frustration*" leading to "*negative attitudes towards the book*" suggests the need for a different textbook or none of these strategies. As discussed in Chapter 6, (see Table 6.4, 6.3.5) these three approaches to texts can be linked with cloze scores. None of these approaches is appropriate for all students in all circumstances.

Bearing in mind the expected consistency of response (see 7.3.4), an arbitrary criterion was used to judge the importance of student responses in terms of teaching strategies. If more than 70 percent of students in a class had ticked one of the multiple choice responses offered for the questionnaire question "*How do you usually use the book?*" (see Appendix D), the corresponding teaching strategy was judged to be important to the situation. This analysis of teaching strategies is presented as Table 7.11. The schools are presented in the same order as in other tables to facilitate comparison between tables.

Table 7.11: Teaching strategies

School & Group identifier	R	T	I	N	School & Group identifier	R	T	I	N
1035					1029				
01	*				1	*			
02			*		2	*			
03		*	*		3		*		
04		*	*		4		*		
05			*		5				*
06			*		6				*
07		*	*						
1036*					1004*				
B		*	*		Blue	*	*	*	
C		*	*		Gren	*	*		
D		*	*		Red	*	*	*	
F		*	*		Viol	*			
G	*	*	*		Yell		*		
L		*	*						
P		*	*						
T		*	*						
W		*	*						
Y		*	*						
Z	*	*	*						

(R= for reference, T= assuming teacher's role, I= as a source of information and N= none in particular)

School & Group identifier	R	T	I	N	School & Group identifier	R	T	I	N
1028					1011				
X1		*			A/C				*
X2		*			A/J		*	*	
X3		*			A/M		*	*	
Y1	*	*			A/R		*		
Y2		*			A/S			*	
Y3		*			B/H		*		
					B/J				*
					B/M		*		
					B/S	*		*	
1020*					1010				
3CS3		*	*		10A		*	*	
4CS1	*				10F		*	*	
4CS2		*	*		10G		*		
5CS1		*			10H			*	
5CS2		*	*		10J		*		

(R= for reference, T= assuming teacher's role, I= as a source of information and N= none in particular)

School & Group identifier	R	T	I	N	School & Group identifier	R	T	I	N
1018*					1007				
94M1		*	*		93B	*	*		
95M1			*		93E		*		
95R1		*	*		94A	*		*	
					94B		*		
					94C	*	*		
					94D	*	*		
					94E	*			
					94F	*	*		
1021*					1031*				
34BY	*				94B4			*	
4.1				*	95A1	*		*	
4.2M	*				95A2			*	
4.2R				*	95A3			*	
4.3K		*			95B4		*	*	
4.3S				*	95B5		*	*	
4.3T				*	95B6		*	*	

(R= for reference, T= assuming the teacher's role, I= as a source of information and N= none in particular)

In Schools 1035 and 1029, where setting is based solely on ability in science, the textbook studied is used mainly as a reference source with the most able (Sets 01 & 1), more as a teaching aid with average students and mainly as a source of information, or none of these strategies, with the least able (Sets 07 & 6). There is a similar pattern in data concerning where the textbook is used, from both at home and in class, for those most able in science, to in class for those least able in science (see Table 7.g). These findings suggests a differentiated approach to the use of the textbook studied.

Selected classes of higher ability and classes in selective schools (Schools 1020*, 1010, 1018*, 1007, 1021*, 1031*) reflect this pattern to some extent. The pattern is less well defined in schools where setting is based on factors other than solely on ability in science (1004*, 1011, 1028 & 1036*). Students in School 1021* had been issued with copies of alternative textbooks which many of them preferred. They were confident that they could cope with whatever textbook was selected for them and were reassured that it would access the appropriate grades at GCSE. This differentiation through textbook resources may account for the apparent lack of preferred teaching strategies using the textbook studied in this school. The data concerning School 1028 indicate a consistent use of the textbook studied as a teacher substitute across the ability range. This evidence may endorse students' remarks and the findings of the recent Ofsted report discussed in Chapter 5 (see 5.2.6) and also in this chapter (see 7.3.2) concerning the inappropriateness of the teaching strategies involving the use of the textbook with some students in this school.

Teachers take account of the available textbook resources when planning teaching strategies. They will have opinions about the extent to which this published material complements their preferred approach to teaching a particular group of students. They may not have been involved in the original course choice and may not be committed to it as discussed in Chapter 5 (see 5.2.1, 5.2.2). There is evidence that in schools where the textbook studied is popular with the staff it is also popular with students (School 1036*). The converse is also true (School 1018*). This finding suggests that there might be a link between student and teacher approval. However, there is no clear pattern within the rest of the data to endorse such an assertion. For instance, student responses at School 1028 (see 7.3.2) would suggest that the teachers' confidence in the textbook studied at that school is misplaced.

Teachers in comprehensive schools where the textbook studied was only used with able students generally disliked the textbook, whereas those in selective schools and schools where it was used across the ability range generally liked the textbook. In all three schools where the textbook was only used with able students (1010, 1020* & 1018*), the textbook had at one time been used across the ability range. This policy had been abandoned partly due to perceived inadequacies in the textbook (see Appendix A). These perceived inadequacies may be reflected in teachers' opinions in these schools. However, student opinions of the textbook (see Table 7.a) are not necessarily prejudiced by their teachers' opinions. The majority of the 36 teachers involved in the study approved of the textbook. However, 44% (16) of them commented that it was most suitable for more able students. This finding supports similar findings reported in Chapter 6 (see 6.2.6, and also 7.2). This awareness provides supporting evidence for the differentiated use of the textbook studied and the finding above that students less able in science are less likely to be expected to use the textbook at home, away from the teachers' supervision and guidance.

Teachers often made favourable comments concerning figures in the textbook studied, which is interesting in the light of the students' general dissatisfaction in this area (see 7.4.2). If figures are an important feature in choice of textbook this difference in students' and teachers' opinions has added significance. This difference in opinions adds weight to the argument that students should be involved in textbook selection. Teachers use the textbook with their students for background reading, for the diagrams charts and tables, and for the questions. Teachers' suggestions for improvements to detailed information may reflect an anxiety to provide for the most able students and to achieve the best grades at GCSE (see also 7.4.1). The call for better questions, review sections and written text reflects the author's views. Almost half the teachers who responded to the questionnaire (17) teach in schools with more than 10% bilingual students and a few were themselves bilingual. In the context of this study it is disquieting that none of the teachers who took park in the study commented on the accessibility of the textbook studied to bilingual students or suggested improvements to the textbook in this area. Although the teachers perceived the need for differentiation in terms of ability in science, there was no recognition of a need for differentiation in terms of language and culture. As gauged by their views, teachers in schools with more than 10% bilingual student were typical of the teachers taking part in the research.

An important aspect of the pedagogical use of textbooks, which was discussed in Chapter 2 (see 2.5-2.5.4), is the manner of presentation of text to students. The techniques listed in Table 7.9 are all suitable. The techniques used varied, discussing the text with students was the most popular means of introducing text and brainstorming was the least popular. Means of presenting text do not account for the variation in student approval of the textbook studied.

Whole-school and departmental policies and the constraints imposed by the availability of resources, appear to limit the range of strategies available to teachers. School philosophy and ethos influence teachers' and students' expectations of lessons and thus further limit the range of approaches viable in particular circumstances. These wider institutional environment matters are described for each of the schools studied in Appendix A. As explained in Chapter 5 (see 5.2.2, 5.2.6), the course is generally used in schools where Science Departments wish to preserve the autonomy and integrity of the separate science disciplines through specialist teaching. Consequently, the biology content is usually only taught by a few members of a Department. These whole-school and departmental factors create a tendency towards consistency in approach within individual schools. However, the evidence from the research indicates the selection of teaching strategies to suit particular groups of students in the majority of the schools studied. There was no evidence of particular teaching strategies being employed in schools with more than 10% bilingual students. Classes in these schools were taught in similar ways to those in similar, monolingual schools.

It appeared from discussions with teachers that textbooks were expected to last much longer in state schools than in independent schools (1004*, 1021*, 1019 see Appendix A). A good stock of textbooks was seen as a worthwhile, necessary resource in the independent schools which were generally better equipped with textbooks and replaced them regularly [see Book Trust 1992 p. 61]. This policy is in line with Book Trust recommendations which considered that "*a school book has a useful life of three years*" [Book Trust 1996]. In state schools the new edition of the textbook was purchased to replace worn out and used stocks. Alternatively, textbook purchase was *on hold* until all the stock was worn out and could be replaced. In these schools the purchase of textbooks was seen as a long term investment. These financial considerations contribute to the reported lack of textbook resources in British schools [HMI 1992 p. 21, Ofsted 1993a p. 19, 1995b p. 17, 1996a paras 240-242, Fisher 1995, Rosenthal 1996] (see Chapter 5: 5.2.1). Ofsted inspections at Key Stages Three and Four during 1994-5 [1996b p. 6] revealed that, "*Provision of suitable science textbooks remains a major problem in one-quarter of schools*". However, five out six of the schools with more than 10% bilingual students studied had sufficient copies of the textbook to issue them to students. Another consequence of financial constraints on textbook purchase is a lack of flexibility to change courses and textbooks in response to changes in students' needs and other influences such as the National Curriculum

There was evidence of differentiated approaches in the use of the textbook studied with classes of different abilities and a variation in availability of resources. Teaching strategies in the schools with more than 10% bilingual students were similar to those in comparable monolingual schools. The schools with more than 10% bilingual students were also generally well resourced. When collating data from classes of a range of abilities it is important to check that there is consistency of teaching strategies and textbook availability between the groups. Otherwise the collation may not be valid. Comparisons in textbook accessibility between classes of different abilities should take into account variations in teaching strategies and resource availability.

7.4.4 Bilingualism

The data provide sound evidence for the consistency of several factors affecting the accessibility of the textbook studied across classes within schools where information concerning bilingual students was collated on a whole-school basis. Four of these schools are selective schools or use the textbook only with selected classes of higher ability (1018*, 1020*, 1021* & 1031*). Inconsistencies surrounding differentiated teaching strategies do not apply in these circumstances. Variations in the percentage student approval of the textbook in these schools was put down to students' concern about accessing the higher grades at GCSE. In Schools 1004* and 1036* there was consistency in percentage student approval and teaching strategies between classes (see Tables 7.a and 7.11) despite the range of abilities taught. These schools were demonstrated as special cases of schools where the textbook was used with students of all abilities. The processing of the data was thus justified.

The analysis of the main sample data has put any findings drawn from the bilingual subsample data into perspective and has indicated its limitations. There were differences between the total numbers of responses concerning language and communication, subject narrative and teaching discourse for monolingual and bilingual subsamples. However, the differences were inconsistent. There were considerable variations between numbers of responses on five language and communication categories. This finding is consistent with the argument put forward in Chapter 1 (see 1.2.7) concerning the possible relationship between bilingualism and the understanding of scientific language. The argument put forward in Chapter 1 linked proficiency in scientific language skills with the degree of diglossia in bilingual communities. Using this argument, one could predict that the scientific language skills of bilingual students would deviate from those of similar monolingual students depending on whether the effect of bilingualism was additive or subtractive.

The degree of diglossia, or use of different languages for different purposes, depends on language use within a wider community. School-community links at School 1018* are described in Appendix A. The predominant second language in this situation is Gujarati (see Table 7.1). So many of the students speak this language that students can use it amongst friends alongside English. Gujarati is used extensively within the wider community. The school has developed cultural links with the Gujarati speaking community and Gujarat. Bilingual teaching, (see Chapter 1: 1.2.4), is possible because the range of second languages is small. There are several Gujarati speaking teachers at this school (In their responses to a follow up questionnaire several Gujarati speaking students reported speaking to science teachers in Gujarati in this school) . One might predict that School 1018* is a diglossic community.

Thirty two (31%) of the students studied at School 1020* are Gujarati speakers. These Gujarati speakers comprise nearly 70% of the bilingual students studied in this school which is far more cosmopolitan than School 1018*. School 1020* caters for speakers of 40 languages (see Appendix A). 4 second languages were spoken by the students studied at School 1018* compared with 16 at School 1020* (see Table 7.1). Table 7.e shows that more languages are spoken in individual classes at School 1020* than at School 1018*. Bilingual teaching and school community links with one specific language speaking community might be inappropriate at School 1020*. It would be a difficult task to provide bilingual teaching in, and cultural support for, all of the 40 or so languages spoken by the students who attend this school (see Appendix A). Although students may use their second language extensively at home, they are less likely than students at School 1018* to use their second language in the wider community or to benefit from cultural links. One might predict that the Gujarati speakers in this school are less likely to be a diglossic community than those at School 1018*.

The transcript of students' conversations during a discussion task made at School 1020* includes two language switches, lines 022-023 and 138 in Transcript 10201A (see Appendix B). These language switches occured in a discourse between students whose second languages are Arabic and Gujarati. The switches involved the odd word in mid sentence. When compared with Mercer, Rosen and Chapman's material [Open University 1988 pp. 16-17, discussed in Chapter 1, see 1.2.7] this discourse is more like a case of *linguistic interference* than a case of *diglossia*. All of the personal talk between these students (covering topics such as boys, make up and chocolate in the full transcript) is in English. This finding may be further evidence in support of the inference that the bilingual community at School 1020* is less diglossic than that at School 1018*.

A follow up questionnaire (see Appendix D) designed to probe the extent of diglossia was administered to students in Schools 1018* 1020* and 1031* as described in Chapter 6 (see 6.3.1). Students indicated which of 18 everyday situations were circumstances where they used English or a second language. The data collected from bilingual students at the three schools are presented as Table 7.12.

Table 7.12 Bilingual students' responses to the follow up questionnaire

Second language used in	More than 13 (72%) of the situations presented	9 -13 (50-72%) of the situations presented	5-10 (28-49%) of the situations presented	less than 5 28% of the situations presented	Bilingual students who responded
School 1018*	2 (4%)	8 (19%)	25 (58%)	8 (19%)	43
School 1020*	1 (4%)	5 (20%)	9 (36%)	10 (40%)	25
School 1031*	0 (0%)	2 (9%)	6 (27%)	14 (64%)	22

Only a small proportion (4%, 4% & 0%) of the bilingual students who responded to the follow up questionnaire in the three schools studied use their second language in more than three quarters of the situations presented. This finding suggests that most the bilingual students who responded were reasonably proficient speakers of English. A similar proportion (23% and 24%) of the bilingual students at Schools 1018* and 1020* use their second language in at least half the situations presented. However, whereas 60% of the bilingual students at School 1020* use their second language in at least 28% of the situations presented, the comparable figure for School 1018* is 81%. This finding may indicate that at School 1018* bilingual students use their second languages in more situations. Fewer bilingual students at School 1031* use their second language in at least half of the situations presented than at either of the other schools. At School 1031* 64% of the bilingual students use their second language in less than 28% of the situations presented. School 1031* has a smaller proportion of bilingual students than either of the other two schools (See Table 6.1, School 1031* 18.2%, School 1018* 86.5%, School 1020 45.1%). 17 languages are spoken by bilingual students at School 1031* compared with 4 at School 1018* and 16 at School 1020*. This finding may indicate that, not surprisingly, second languages are used in more situations in circumstances where there are more bilingual speakers who speak the same language. These findings may be further evidence in support of the inference that School 1018* is a more diglossic community than either School 1020* or School 1031*.

The argument put forward in Chapter 1 (see 1.2.6, 1.2.7) predicts that Gujarati speaking students at School 1018* will have higher scientific language skills than those at School 1020*. One might speculate that their dislike of the textbook studied was due to a finer perception of the linguistic faults identified by many other students. The argument explains this finer perception as linguistic awareness heightened by experience within a diglossic community.

The two schools are similar in many respects and recent research [Carr-Hill, Passingham, Wolf & Kent 1996 Table 8.2 p. 113] suggests that standards of literacy in English are similar in Indian communities in London (School 1020*) and outside London (School 1018*). It is thus appropriate to make such comparisons between these two schools. They are city schools where the Nuffield Co-ordinated Sciences course was first used with students of all abilities but is now only used only with those most able at science. Similar teaching strategies are employed in the two schools and they generally use the same edition of the textbook studied (see Tables 7.6, 7.11). Teachers in both schools said that they disliked the textbook. The textbook is used less in School 1018* where it is not issued to students (see Table 7.g). There was no evidence to show that the mix of social class of the bilingual students in the groups of students studied, a factor which Gilborn and Gipps [1996 p. 80-81] consider important and often neglected in research studies, was different in the two schools. One difference between the schools is the percentage of students who are eligible for free school meals (18% at School 1018* and 32% at School 1020* see Appendix A). This factor has been linked with academic achievement and social class in other studies [see Sammons 1994 p. 3]. However, there were no data available on the proportions of students entitled to free school meals in the classes studied, or separate statistics on the eligibility of bilingual and monolingual students to free school meals in the classes studied. The factor was therefore not included in the analysis. There is a gender imbalance in the bilingual subsample from 1018* (see 7.2) which, if the argument holds, might suggest that diglossia is more developed in the girls than in the boys. The bilingual subsample from School 1020* was balanced in terms of gender (Of the 32 Gujarati speakers in this subsample 15 are boys and 17 are girls).

7.4.5 The limitations of the questionnaire data

The questionnaire data have provided a context for various inferences concerning the effects of student bilingualism on the accessibility of school science text and for the development of these arguments. However, the data presented thus far are not adequate to support or refute the inferences concerning diglossia in Schools 1018* and 1020* in section 7.4.4. There are several reasons for these limitations in the data. First, the data are based on student and teacher judgements which depend on motivation, opinion and classroom attitude, which in turn depend on other factors such as school ethos and teacher competence. Secondly, the data are subjective and are difficult to standardise between schools. Thirdly, the data may be biased. With questionnaires such as these, subjects may be more likely to respond if they have critical comments to make. The open-ended nature of some of the questions has limited the amount of statistical manipulation appropriate for use with the data. The data collected using the cloze procedure described in Chapter 6 (see 6.3.4) which is the subject of the second part of this analysis is more satisfactory than the questionnaire data in some respects. It is less influenced by classroom context and gives a clearer assessment of textbook language accessibility. The cloze procedure is only dependent on motivational and attitudinal factors concerned with the textbook itself. These factors are relevant to research into accessibility. The cloze task is an objective assessment of a text's accessibility to an individual. There is less likelihood of bias using a cloze procedure and the closed nature of the cloze task enables statistical manipulation of results. The cloze task data can be used to probe particular linguistic aspects of the accessibility of text set out in Chapter 3. However, the questionnaire data analysis provided important background information which was unattainable through a cloze procedure.

7.5 The cloze task data

In the terms of the research agenda set out in Chapter 4 (see 4.2) the data collected through the cloze task are linked most closely with the language accessibility of the textbook studied. The cloze task was presented to students in three parts, each related to an extract from the textbook studied (sections B6.1 & B6.2, B2.4 and B8.2 see Appendix D). Students' responses to cloze task deletions were categorised, correct, incorrect or no response/blank. These data were coded and entered into computer spreadsheets prepared for each class. Intelligible misspellings and plurals in place of singular words and vice versa were counted as correct responses. Responses of more than one word including the correct response were treated as incorrect responses on the basis that additional words changed the meaning or signified misunderstanding. Recognisable words which were not correct responses were counted as incorrect. Blanks and illegible responses were counted as blank. All codings were listed in a *directory of responses* which also included grammatical analyses, notes on teaching discourse messages, cohesive ties and linguistic signposts. Details of practical difficulties affecting understanding due to non-semantic factors specific to each deletion, such as links with other deleted words, position in sentence, word frequency, linked deletions, the levels of explanation of science register words and sentence length were also recorded in this directory. The coded data were processed by computer producing percentage correct responses, for each student, for each extract. Subsequently the data were processed further to produce specific linguistic information related to the semiotic planes model of language discussed in Chapter 3 (see 3.7.1).

7.5.1 Cloze data analysis

The cloze task data are presented as Tables 7.h, 7.i, and 7.j in Appendix E. The data were collated on a class by class basis to facilitate comparison between classes and with the questionnaire data presented in previous tables. Data concerning each extract are presented in turn to enable easy comparisons between classes and schools. Important variation in sections covered and teaching strategies used, occurs at the class level of data organisation. The cloze scores are presented on the left hand side of the tables as totals of students reading an extract at a frustration level, an instructional level and an independent level. These levels are supported by research [Bormuth 1969, 1967, 1968, Rankin and Culhane 1969] and are explained in more detail in Chapter 6, (see 6.3.5). In this study they are used in order to classify student performances rather than as a diagnostic tool. This form of analysis is based on the assumption that reading proficiency is not well described by a linear function. It is based on the idea of a series of steps in proficiency rather than treating reading as a linear function (see The Bullock Report [DES 1975 p. 33]).

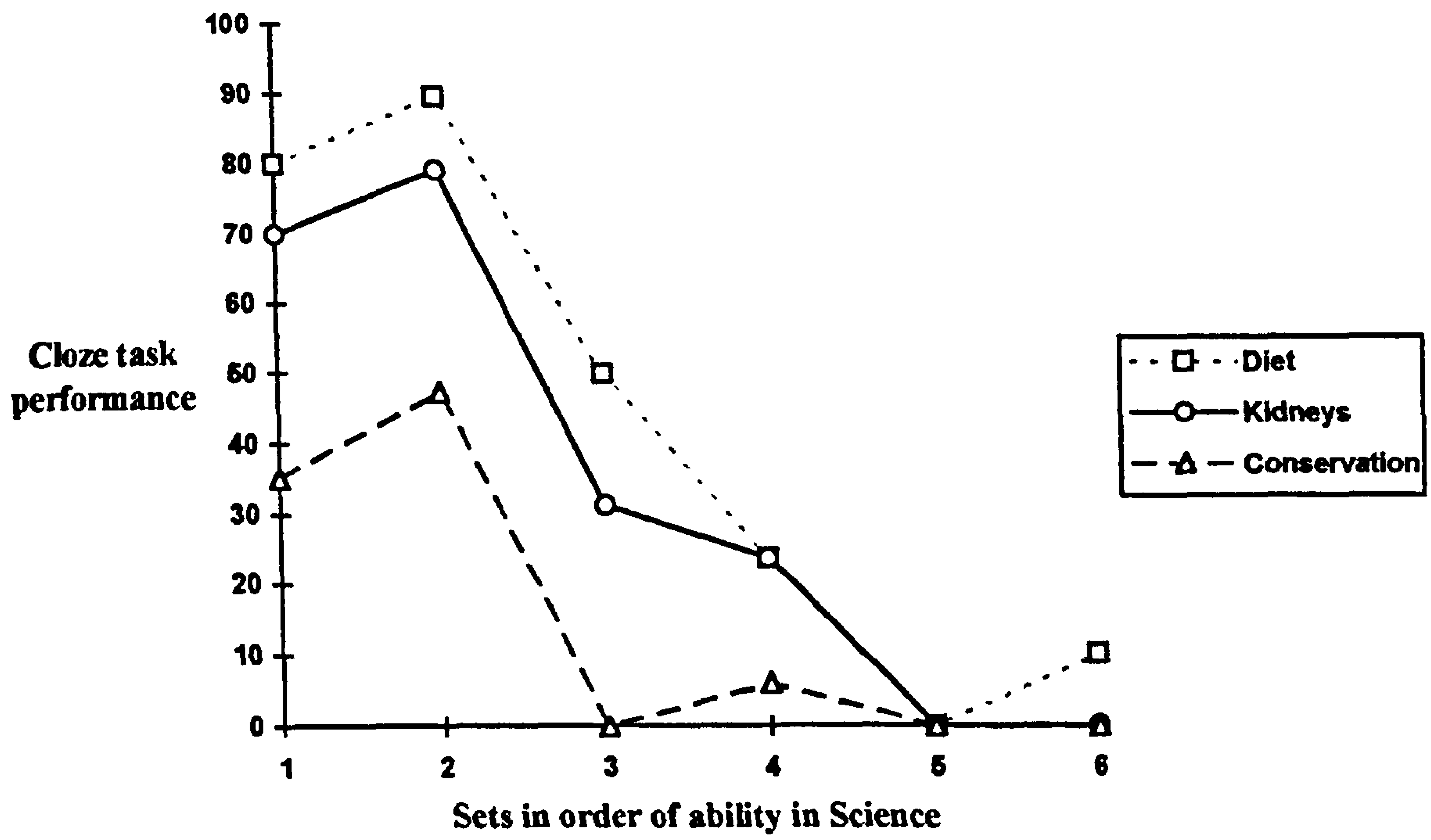
The data are presented in a different form on the right of the table. These columns show the average cloze score for each class studied and the breakdown of that score into three semiotic planes described in Chapter 3 (see 3.7.1). Each item of data was assigned to one of three categories, science lexis, scientific grammar and the school science textbook genre. This categorisation is an extension of Chapman and Louw's [1986 see Chapter 6: 6.3.3] concept of cloze gap filling as a three-way tug between structure, cohesion and register. The assumption was made that cloze gap filling requires an understanding of lexis, grammar and genre. However, each gap filled relies on one component in particular and this was the basis of the categorisation. As the media of expression of the other planes of meaning, data items reliant on Standard English and writing style were difficult to identify and were not considered.

The linguistic information recorded in the *directories of responses* informed the classification of the data. Frege's rules for distinguishing between concept words and object words [Kenny 1995 pp. 119-121] were helpful in deciding between scientific lexical (concept) and common parlance (object) meanings of words. In the cases of the diet and kidneys extracts the data were equally divided between the three categories. The extract on conservation includes more everyday discourse and less scientific lexis that the other extracts. In this case the distribution was 12:20:22, lexis: grammar: genre.

These data confirm the finding reported in Chapter 6 (see 6.3.5) that the extract about conservation was the most difficult of the three extracts (see Fig 7.6). The average cloze scores for the diet and kidneys extracts were generally better than those for the conservation extract. In 27 classes out of 79 (34%) all the students read the conservation extract at the frustration level. In 46 classes (58%), over 80% of the students read this extract at the frustration level. This included 32 (73%) of the classes in schools where students of all abilities use the textbook studied and 11 (85%) of the selected higher ability classes, but only 3 (14%) of the classes in selective schools.

Performances were much better on the diet and kidneys extracts. Both the levels of understanding data, and the average cloze scores, provide further evidence in addition to that presented in Chapter 6 (see 6.3.5) to show that the diet and kidneys extracts were of similar difficulty (see Fig 7.6). However, the pattern of achievement reported above is also reflected in these data. Students in selective schools performed better than students in selected classes of higher ability in comprehensives, whilst classes in schools where students of all abilities use the textbook studied performed least well. That students in some classes in schools where students of all abilities use the textbook should perform least well is to be expected, assuming that achievement is linked with ability. However, one might expect comparable results between selected classes of higher ability using the textbook in all ability schools, top sets in all ability schools where all students use the course (e.g. 1035 01, 1029, 01 1028 X1 & Y1) and classes in selective schools. Although this prediction holds to a certain extent, selected classes of higher ability did not achieve as much as recognised top sets and students in selective schools. These findings may link with findings concerning differences in teaching strategies, frequency of use, place of use and availability of resources. The possible link between students' ability in science, as indicated by their allocation to science sets, and cloze task performance, was investigated using the data from School 1029 shown in Fig 7.6. Cloze task performance was calculated as the total percentage of students reading the extracts at the instructional and independent levels. The sets in this school are organised in order of ability in science as indicated by test results and teacher recommendation (see Fig 7.3)

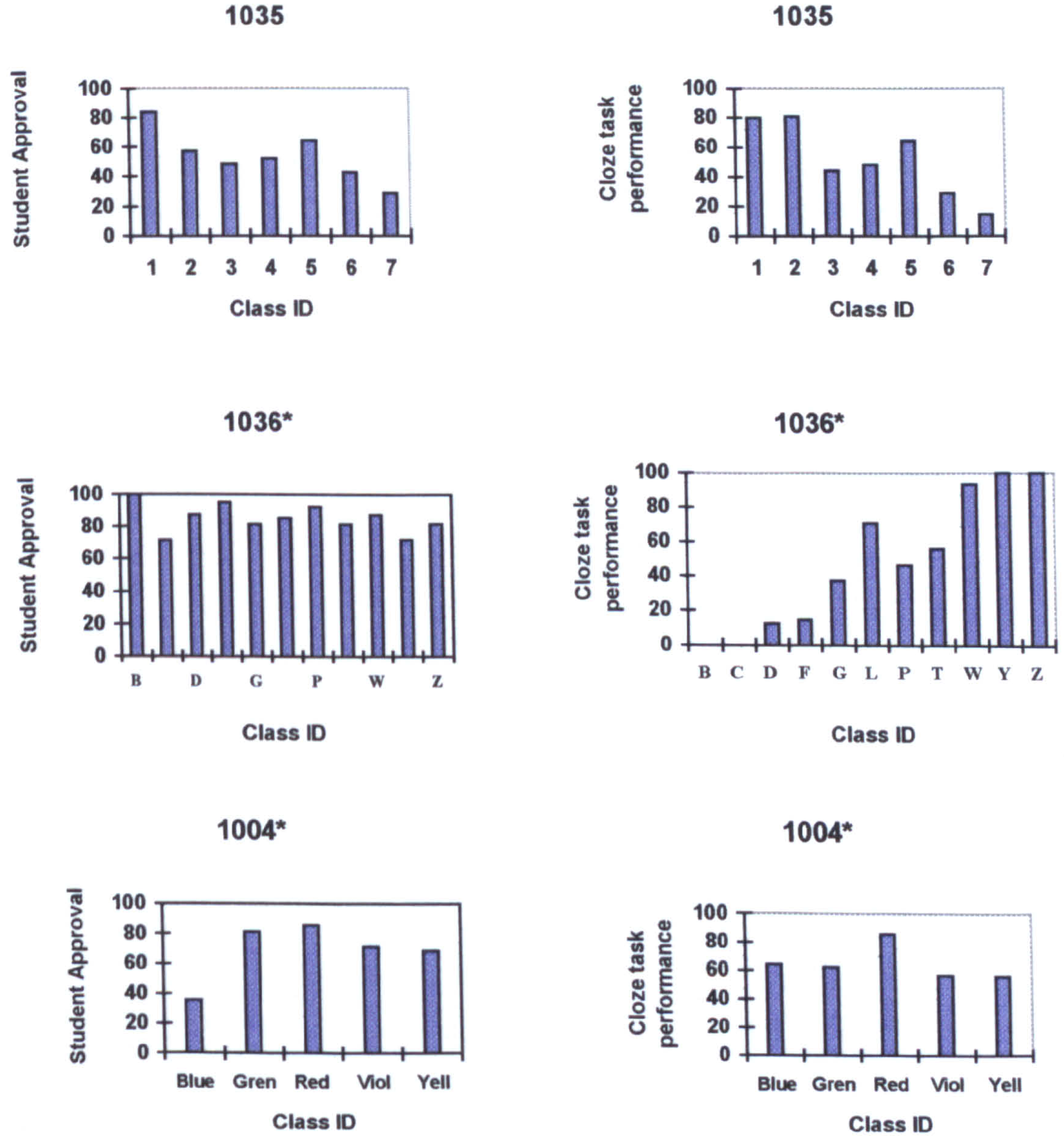
Fig 7.6: Cloze task performance and ability in science in School 1029



As expected, Fig 7.6 shows a link between cloze task performance and students' ability in science. Less than 10% of the students in School 1029 are bilingual. The link between cloze task performance and ability is reflected throughout the data. Cloze task performance was broadly consistent across the two sets of highest ability in science for all three extracts. In fact, more students in the second set read all three extracts at the independent or instructional levels than their colleagues in the set of highest ability in science. There a was similar consistency in average cloze scores for the two sets (see Tables 7.h, 7.i, 7.j) which were as follows, diet 50.5% & 52.9%, kidneys 50.0% & 50.4%, conservation 37.1% & 39.3%. A statistical analysis of these data (see Table 7.k) showed that there was no significant difference between the cloze scores achieved by the two sets on all three extracts. These two sets represent the top 39% of the year group studied in terms of ability in science. Far fewer students read the extracts at the independent and instructional levels in the third and subsequent sets. Average cloze scores for these sets reflect this trend (see Tables 7.h, 7.i, 7.j).

In as much as there are links between ability in science and student approval (see Fig 7.3) and ability in science and cloze task performance (see Fig 7.6) there should be tentative links between student approval and cloze task performance. Fig 7.7 compares percentage student approval and cloze task performance data from Tables 7.2 and 7.i from selected schools in order to enable the exploration of possible links between these data.

Fig 7.7: Cloze task performance on kidneys extract and percentage student approval in Schools 1035, 1036* and 1004*



(School 1035 n= 139, School 1036 n= 171, School 1004* n= 74)*

The data from the three schools illustrated in Fig 7.7, represent a school (1035) where percentage student approval varied with ability and two schools (1036*, 1004*) where all students use the textbook and where percentage student approval was generally high. The histograms demonstrate the general finding that there does not appear to be a clear link between percentage student approval and cloze task performance. For instance, percentage student approval was very high at School 1036* across all classes. Cloze task performance does not reflect this pattern.

7.5.2 Analysis of the cloze scores

Figures 7.8-7.10 are presentations of data from the right of Tables 7.h-j which shows how the average cloze scores for each extract broke down into scientific lexis, scientific grammar and the school science textbook genre. The data are presented from highest average cloze scores on the left to lowest on the right. The coloured shading indicates the part of each score derived from each of the three semiotic planes studied.

Fig 7.8 Diet extract: breakdown of average cloze scores

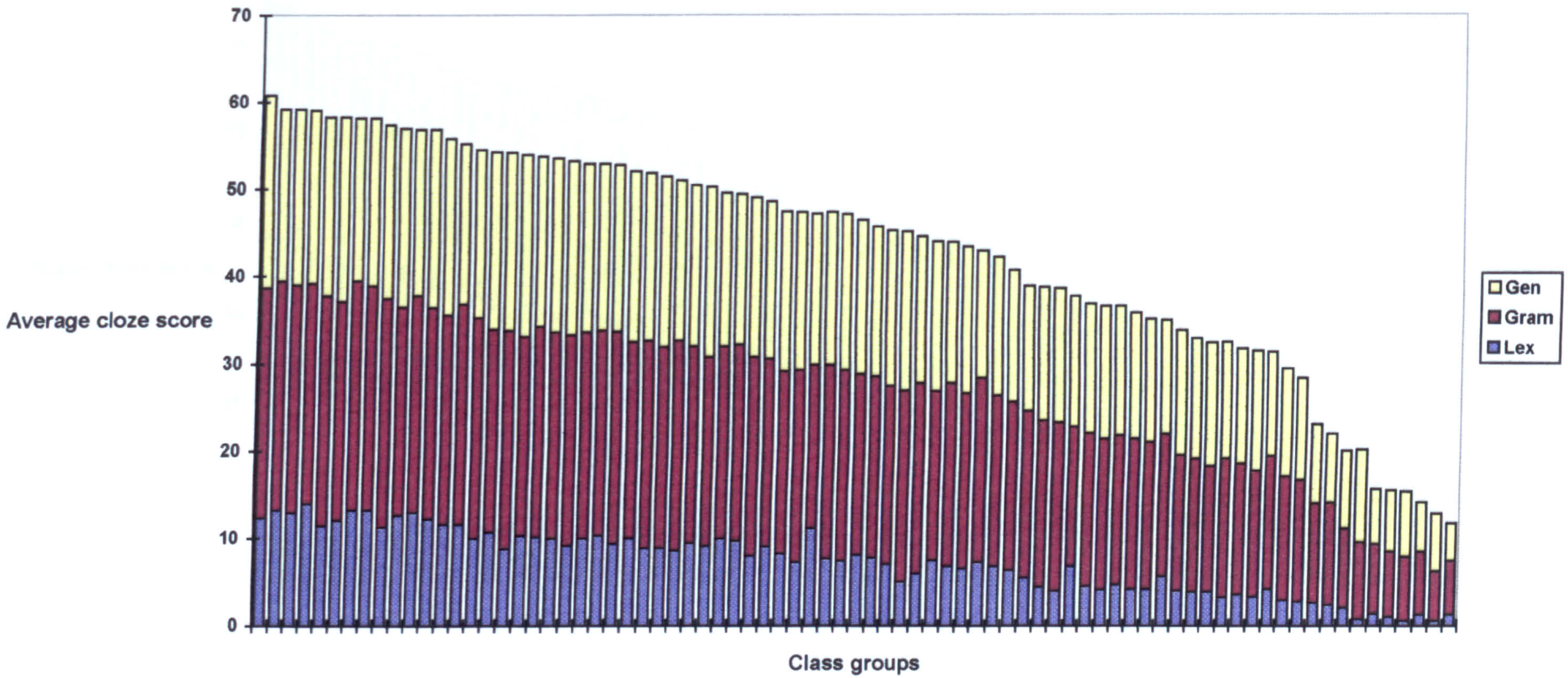


Fig 7.9 Kidneys extract: breakdown of average cloze scores

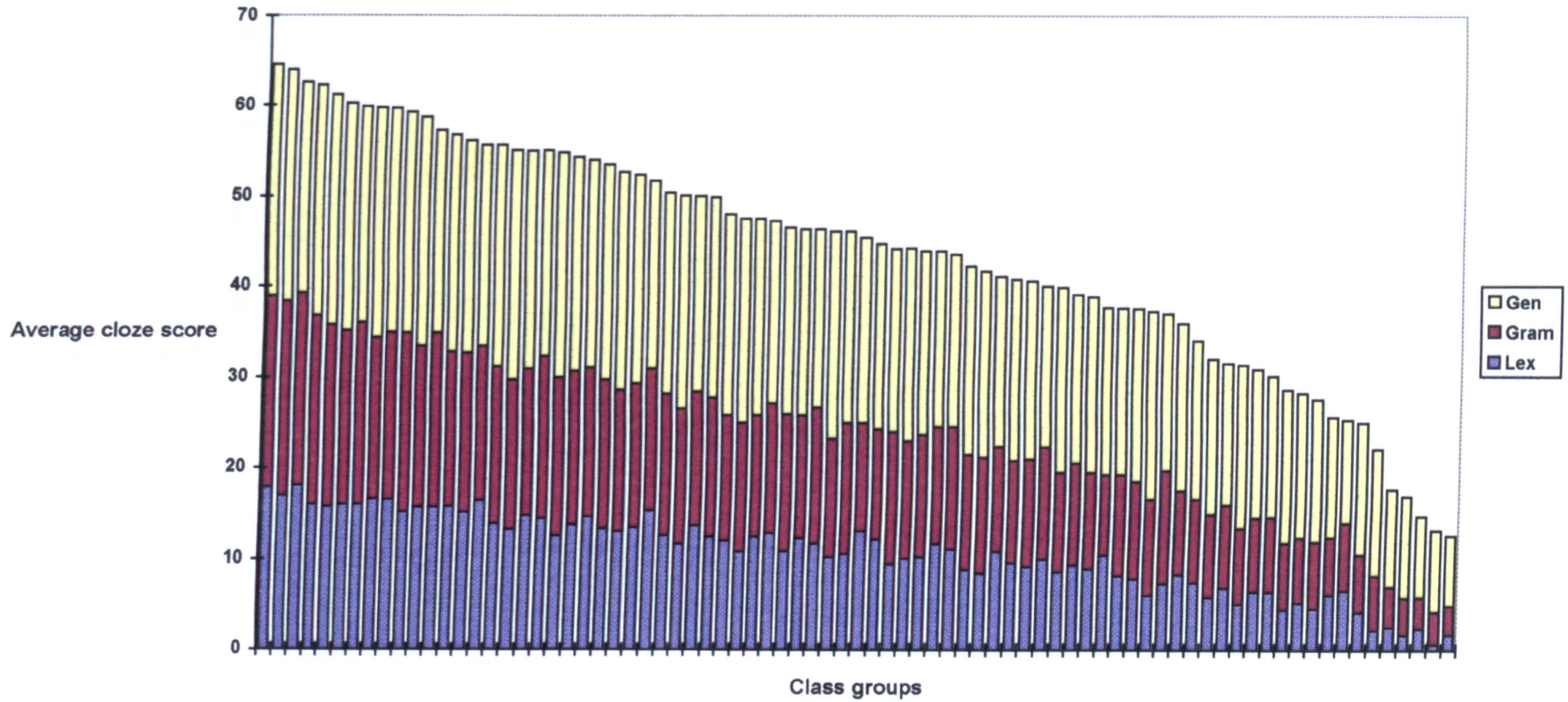
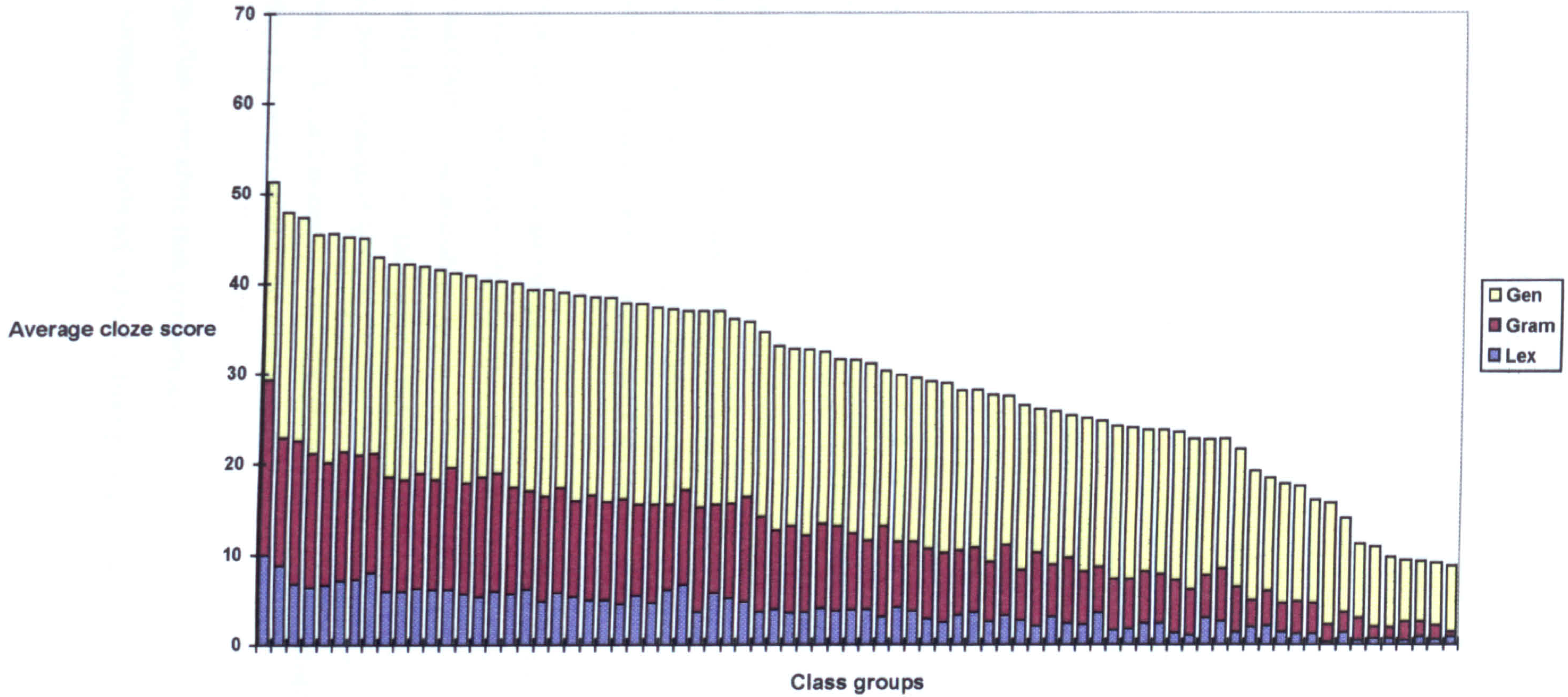


Fig 7.10 Conservation extract: breakdown of average cloze scores



Each of these histograms demonstrates trends in the data. Scores on the lexical, grammatical and generic aspects of the tasks gradually decrease with decreasing total cloze scores. It therefore appears that none of the semiotic planes is totally dependent on another one. It seems more likely that they all contribute to an understanding of a text.

The components generally made different contributions for each of the three extracts, but these contributions were consistent across the seventy nine classes studied. In the case of the diet extract, grammar scores were highest followed by genre scores and lexis scores. Lexis typically contributed about a fifth of the overall score. In the case of the kidneys extract, genre scores were highest, followed by grammar and lexis. Average scores for lexis were generally better than those on the diet extract. Lexis typically contributed about a quarter of the overall score. In fact, the improved lexis scores may account for the generally slightly higher total average scores for this extract. The conservation extract is different from the other extracts, it includes less lexical cloze items and was generally more difficult. Total cloze scores were generally less than those for the other two extracts. In Chapter 6 (see 6.3.5) it was shown that the difficulty may be linked with a lack of cohesion in the conservation extract. Genre scores were highest for the conservation extract, followed by grammar and lexis. The reduction in lexis scores did not, on its own, account for the general reduction in total cloze scores. Whereas genre scores were similar to those for the other two extracts, grammar scores were generally lower.

Average cloze scores from classes in the schools with more than 10% bilingual students (1004*, 1018*, 1020*, 1021*, 1031* & 1036*) generally reflected these trends. Classes from these schools generally performed well on the cloze tasks. They constitute half (38, 48%) the total number of classes studied (79) yet they were consistently over-represented in the top twenty average cloze scores (diet 13, kidneys 13, conservation 13) and underrepresented in the bottom twenty average cloze scores (diet 5, kidneys 5, conservation 6) for each extract.

7.5.3 Bilingualism and cloze task performance

Table 7.13 summarises whole school and subsample cloze task performances.

Table 7.13 A summary of cloze task performances

School Number and organisation of science sets using the textbook	Diet		Kidneys		Conservation	
	n=	%	n=	%	n=	%
Schools where students of all abilities use the textbook						
1035	59	42.5	79	56.8	22	15.8
1029	46	46.9	38	38.8	17	17.3
1036*	78	45.6	85	49.7	13	7.6
1036#	9	50.0	8	44.4	0	0.0
1036+	69	45.1	77	50.3	13	8.5
1004*	59	79.7	48	64.9	28	37.8
1004#	15	62.5	11	45.8	6	25.0
1004+	44	88.0	37	74.0	22	44.0
1028	69	45.7	65	43.0	26	17.2
1011	67	40.6	59	35.8	4	2.4
Schools with selected "higher ability" sets						
1020*	52	51.0	56	54.9	5	4.9
1020#	26	56.5	25	54.3	1	2.2
1020+	26	46.4	31	55.4	4	7.1
1018*	48	64.9	47	63.5	1	1.4
1018#	43	67.2	42	65.6	1	1.6
1018+	5	50.0	5	50.0	0	0.0
1010	52	46.0	61	54.0	21	18.6

*(Schools with more than 10% bilingual students marked *, bilingual subsamples marked #, monolingual subsamples marked +)*

School Number and organisation of science sets using the textbook	Diet		Kidneys		Conservation	
	n=	%	n=	%	n=	%
Selective schools						
1021*	108	81.2	109	82.0	55	41.4
1021#	35	81.4	35	81.4	19	44.2
1021+	73	81.1	74	82.2	36	40.0
1031*	143	86.7	148	89.7	71	43.0
1031#	26	86.7	27	90.0	9	30.0
1031+	117	86.7	121	89.6	62	45.9
1007 Total	122	90.4	124	91.9	57	42.2
1007 Boys only	57	87.7	60	92.3	25	38.5
1007 Girls only	65	92.9	64	91.4	32	45.7

*(Schools with more than 10% bilingual students marked *, bilingual subsamples marked #, monolingual subsamples marked +, Separate boys and girls performances are provided for School 1007 because it is compared with two boys' schools.)*

Cloze task performance in School 1004* was consistently better than in other schools where the textbook is used with students of all abilities, on all three extracts. However, as an independent school catering for the children of international businesspeople and diplomats, it is a special case. Students in the bilingual subsample performed consistently less well than their monolingual peers on all three extracts. This finding may provide evidence for the *subtractive effect* of bilingualism on understanding scientific language discussed in Chapter 1 (see 1.2.7). Cloze task performance was consistent between all of the other schools where the textbook studied is used with students of all abilities.

There are three schools where the textbook studied is only used with selected classes of students of higher ability. The bilingual students at School 1018* mainly belong to one large language community (95% of the school population). School 1020* is much more cosmopolitan (see 7.4.4). School 1010 is a country school. Of these three schools, cloze task performance was best at School 1018* on the diet and kidneys extracts. This finding may provide evidence for the *additive effect* of bilingualism on understanding scientific language discussed in Chapter 1 (see 1.2.7). Performance on the conservation extract was similar in these schools to that in the schools where the textbook studied is used with students of all abilities and worst at School 1018*. One might expect students affected by a *subtractive effect* of bilingualism on understanding scientific language to have been selected for classes for students of lesser ability in science in Schools 1018* and 1020*.

Cloze task performances are consistent at the selective Schools 1007, 1021* & 1031*, including the performances of bilingual subsamples. Bilingual students in these schools do not mainly belong to a single language community and the extent of diglossia is limited. Bilingual students affected by a *subtractive effect* of bilingualism might not be selected for these schools. Selective school students performed consistently better than students from selected higher ability sets in comprehensives.

7.5.4 Bilingualism and average cloze scores

Average cloze scores and a breakdown of cloze scores for the bilingual students in schools with more than 10% bilingual students are presented as Table 7.14.

Table 7.14: Average cloze scores for bilingual students

Part A: Diet extract

School ID	Number of bilingual students	% bilingual students	Bilingual students' average cloze scores				Whole school av cloze score	Mono subs av cloze score
			Lex	Gram	Gen	Tot		
1004*	24	32.4	8.3	20.2	17.7	46.3	52.1	54.9
1036*	18	10.5	5.4	18.8	13.8	37.9	40.0	40.3
1018*	64	86.5	8.3	21.1	18.4	47.8	47.5	45.6
1020*	46	45.1	6.0	19.4	17.4	42.8	42.1	41.5
1021*	43	32.3	11.5	23.8	17.9	53.2	54.1	54.5
1031*	30	18.2	9.9	23.5	18.2	51.6	52.3	52.5

(av = average, Mono subs = monolingual subsample, Lex = scientific lexis, Gram = scientific grammar, Gen = school science textbook genre, Tot = total score)

Table 7.14 continued

Part B: Kidneys extract

School ID	Number of bilingual students	% bilingual students	Bilingual students' average cloze scores				Whole school av cloze score	Mono subs av cloze score
			Lex	Gram	Gen	Tot		
1004*	24	32.4	9.3	11.2	19.8	40.3	49.3	53.6
1036*	18	10.5	7.7	10.7	18.6	37.1	41.6	42.1
1018*	64	86.5	12.1	12.6	20.4	45.1	44.0	37.0
1020*	46	45.1	10.0	10.7	18.9	39.6	41.8	43.6
1021*	43	32.3	14.7	18.0	22.5	55.1	54.6	54.4
1031*	30	18.2	15.3	17.6	23.4	56.3	55.7	55.7

Part C: Conservation extract

School ID	Number of bilingual students	% bilingual students	Bilingual students' average cloze scores				Whole school av cloze score	Mono subs av cloze score
			Lex	Gram	Gen	Tot		
1004*	24	32.4	2.6	6.6	16.9	26.1	37.6	43.1
1036*	18	10.5	2.1	4.7	15.2	22.0	25.9	26.4
1018*	64	86.5	2.9	7.4	18.2	28.5	28.8	30.7
1020*	46	45.1	2.9	6.6	17.6	27.1	27.4	27.7
1021*	43	32.3	6.5	12.2	22.1	40.9	39.2	38.4
1031*	30	18.2	4.2	11.7	21.3	37.2	41.1	42.0

(Whole school av cloze score = whole school average cloze score, Mono subs av cl score = monolingual subsample average cloze score, Lex = scientific lexis, Gram = scientific grammar, Gen = school science textbook genre, Tot = average total bilingual score)

Bilingual students tended to achieve lower average cloze scores than their monolingual peers in the schools (1004* & 1036*) where the textbook studied is used with students of all abilities. Bilingual students' average scores were generally similar to their monolingual peers' average scores in schools where the textbook is only used with selected classes of higher ability (1018* & 1020*) and in selective schools (1021* & 1031*). However, the bilingual students at School 1018* performed slightly better than their monolingual peers on two extracts and those at School 1020* performed slightly less well than their monolingual peers on two extracts. Bilingual students at School 1031* performed less well than their monolingual peers on the conservation extract. Bilingual students at School 1018*, where the majority belong to a single language community, scored consistently higher than those at School 1020*, which is more cosmopolitan, on the first two extracts and slightly higher on the third extract. These findings are consistent with the theoretical position set out in Chapter 1 (see 1.2.6-1.2.7). The cloze score breakdown into linguistic components follows the trends for the main data set out in section 7.5.2 and illustrated in figs 7.8-7.10.

7.5.5 Follow up study

A limited study was carried out using the cloze task with students in a Special School (School 1009, see Appendix A). These students found the task very difficult, even when they used a taped version of it. This school serves students of a wide range of ability and with disabilities and learning difficulties. It would be wrong to assume that any difficulties in reading the textbook studied were entirely a result of physical disability. Only one of these students is bilingual. All these students were taught the biological content of the course by the same teacher. They were given their regular classroom assistance. There were six adults including the researcher available for 21 students. These were split into three groups in separate rooms. Responses varied from some students who tackled the task just as students in the other schools in the study might, to some who found the task very difficult, to a few who gave up on the task very quickly.

The majority of these students wrote in their responses booklets that they liked the textbook studied. This was very interesting because their response to the task indicated that, in the main, they found the material presented in the cloze task very difficult to read. They found the textbook "*long winded*" with "*silly questions*". Their teacher uses the textbook mainly for its diagrams in conjunction with a *teacher narrative* and several students explained that the textbook would be better with more diagrams and less print. The fact that the students liked the textbook in these circumstances would suggest that this way of using the textbook is reasonably successful and serves to make it more understandable. It would seem that, although text and illustration are both visual media, illustration is more accessible than text, even to those with impaired vision. Several students, not surprisingly, suggested that the textbook would be better with larger print. Some used magnifiers to help them read it. None made use of the closed circuit TV equipment available.

In the author's opinion, the teacher narrative style could be effective with the bilingual students who have difficulties with textbooks. It includes a reworking of text tailored to the linguistic and conceptual needs of the individual or small group and includes the *role borrowing* strategy described in Chapter 3 (see 3.2.1). The material may be summarised and re-presented in alternative ways. The teacher narrative may also place the material presented in the written text in an appropriate context. It involves editing the written text to relevant material. Editing is particularly appropriate when considering content not required by the National Curriculum. Converting the written text into a verbal text provides the student with extra semantic clues through phonetics, and phonological information such as pauses, emphasis and intonation. Much of the descriptive content is translated from Standard English into the, more digestible, locally appropriate, common parlance (discussed in Chapter 3, see 3.2.1). It also enables instant, individualised conceptual and linguistic feedback, summary and recap of the material.

In the context of this study it is interesting to compare the success of teacher narrative with that of the audio cloze task. Student performances suggest that the taped task was as difficult as the written task. The audio cloze task includes the phonological and phonetic semantic clues provided by the teacher narrative. One might conclude that this is less important to student's understanding than the linguistic, conceptual, summarising and contextual aspects of the teacher narrative. The audio task provides opportunities for instant recall and repetition, as does the written text. It does not provide the opportunities for feedback and summary and individualised reworking presented in the teacher narrative. It is possible that this style of teaching owes a lot of its success to the favourable size of teaching groups enjoyed at School Number 1009, the informal atmosphere which this helps to generate and the individualised teaching that it facilitates.

7.5.6 A discussion of the cloze data

In terms of the research agenda set out in Chapter 4 (see 4.2) the cloze task performance data and the average cloze score data relate to *language accessibility.* The cloze task data will be discussed in the light of the questionnaire findings (which relate to the *classroom context*, see 7.4-7.4.4) and the school profiles (which relate to the *institutional environment*, see Appendix A). This discussion gives an insight into the accessibility of the textbook studied to bilingual students, the major issue addressed in the research questions discussed in Chapter 4 (see 4.2).

A statistical analysis was carried out on the major findings in order to ascertain the statistical significance of any differences in data sets. This analysis is presented as Table 7.k in Appendix E. The cloze task performance data is based on a reprocessing of raw data and it was therefore difficult to analyse differences in these data sets using simple statistical tests. The significance of the differences between samples and between subsamples in terms of average cloze scores, which are based on the same raw data as cloze task performance, were tested using standard statistical tests (*see footnote to Table 7.k for details*). The t-test is based on the assumptions that data sets form normal curves and have similar variances. These assumptions were tested using the Chi. squared test (normal curves) and F-test (variances). The inferences fell into four categories. Where data sets pass the tests of assumptions, differences between data sets may be found to be either *statistically significant*, or *statistically not significant* using the standard t-test. Where data sets fail the chi squared, goodness of fit test, inferences are *not proven*. Where data sets pass the goodness of fit test, but fail the variance test, it is possible to infer that there is a difference between the data sets due to the difference in their variances combined with a difference in their means. A bigger variance implies a broader range in cloze scores. In samples where the mean cloze score is close to the Instructional/Frustration boundary (44% see Chapter 6: 6.3.5) this is a direct indication that more students read the text in question at the frustration level. In one case the difference between the data sets was further tested and found to be *statistically significant* using a non-parametric statistical test (the Mann-Whitney U-test [Rees 1985 pp. 123-126]).

The cloze task data reveal that students consistently found the conservation extract difficult. The difficulty of this extract was such that even in situations where a majority of students liked the textbook studied (e.g. School 1036*), most of them did not understand this section. In five out of six schools with more than 10% bilingual students (1004*, 1018*, 1020*, 1031*, 1036*), bilingual students' cloze task performance and average cloze scores were generally lower on this extract compared with their monolingual peers (*For 1004* and 1031* the differences are statistically significant using the t-test. For 1018*, 1020*, 1036* the differences are statistically not significant*). This pattern was not observed in the data collected concerning the other extracts. In the case of School 1031*, whereas the bilingual students performed similarly to their monolingual peers on the diet and kidneys extracts, they performed significantly worse than their monolingual peers on the conservation extract (*For diet and kidneys, not proven. For conservation, statistically significant difference using the t-test*). These findings may indicate that the conservation extract includes some features which bilingual students find particularly difficult.

The readability formula analysis discussed in Chapter 6 (see 6.3.5) did not pick up this difficulty in the conservation extract. As discussed in Chapter 6 (see 6.3.5), the cloze data may reflect a lack of cohesion in this extract. Cohesion was identified as an important element in text readability in Chapter 2 (see 2.3.4) and a lack of it is a serious flaw in text written for school students. The directory of responses for this extract also reveals that it includes difficult grammar and long sentences. Various students and teachers interviewed during the study considered technical words to be the most difficult aspect of scientific text, yet this extract contained much less scientific lexis than the diet and kidneys extracts. The difference is that, whereas various devices are used in the diet and kidneys extracts to explain lexis, in the conservation extract understanding of some difficult terms such as *habitat, climax* and *succession* is assumed. The findings suggest that scientific grammar can also cause difficulties evidenced by the lower grammar scores for this extract. It was also shown that even when there is only a relatively modest amount of scientific lexis in a piece of text it should be carefully introduced and explained. As discussed earlier (see 7.3.3), some bilingual students suggested adding a glossary to the textbook studied.

There was a consistency in the breakdown of cloze scores into lexis, grammar and genre for each of the three extracts. This finding is consistent with the theoretical position developed in Chapter 3 (see 3.7.2). The evidence suggests that language awareness skill in the semiotic planes develops concurrently. The data seem to be evidence for a general scientific language skill which develops consistently. Variation in the contributions of the semiotic plane components between the three extracts can be explained through differences in presentation, the contribution made to understanding by figures, the difficulty of the grammar and the style of writing. Understanding of scientific lexis may depend on the presentation of figures. The consistency in cloze score breakdown was also reflected in schools with more than 10% bilingual students and within the bilingual subsamples within those schools. This finding suggests that if bilingualism affects scientific language skill, it does not affect particular language components. Bilingualism, is a general factor which is no different in its effect from the other influences on the understanding of scientific language which give rise to a range of average cloze scores, such as ability in science and the availability of resources. Although classes in schools with more than 10% bilingual students appeared to do relatively well in terms of average cloze scores, this may be a reflection of the fact that selected classes of higher ability and selective schools are over represented and that School 1004* is a special case of a school where students of all abilities use the textbook studied.

Students scored best in terms of lexis on the kidneys extract. It was pointed out in Chapter 6 (see 6.3.6) that the figures accompanying this extract are expositive rather than illustrative as in the other extracts. They are scientific diagrams drawn using the conventions of the scientific register as discussed in Chapter 3 (see 3.4.1) as opposed to the photographs and map illustrating the other extracts. The text of the kidneys extract refers to the figures which explain some of the scientific lexis. These are almost like *visual definitions* of *input* and *output* and the positions of organs in the body. As one group of students pointed out, at best, the illustrations in the other extracts provide examples of matters explained in the text, at worst, they are superfluous. As discussed earlier (see 7.4.2), students were very critical of the figures in the textbook studied.

The fact that there did not appear to be a link between student approval and cloze task performance suggests that written text understanding may not be an important factor in student approval. However, there was consistent criticism of the figures. These findings may indicate that graphical text is are an important factor in student approval of textbooks. The link between cloze task performance and ability in science found in this research is further evidence for Kress's [1985b p.143] remarks reported in section 3.3 concerning the link between the "*being scientific*" and "*mastery of requisite genres*". Cloze task performance and average cloze scores were shown to be consistent within the top 39% of students in terms of ability in science. It was explained in Chapter 3 (see 3.7.3) how scientific language is important in both the expression of scientific ideas and as tool for original scientific thought. It is therefore not surprising that skill in understanding science textbooks is linked with a student's overall scientific ability.

Consequently, one would expect to find that able students would achieve equally well at the cloze task. The finding that selected classes of higher ability in comprehensive schools generally achieved less than classes in selective schools is thus a cause for concern. The group of three comprehensives with selected classes of higher ability (1010, 1018* & 1020*) and the group of three selective schools (1007, 1021* & 1031*) each include two schools with more than 10% bilingual students. The textbooks are issued to students throughout Key Stage Four in all of the selective schools, whereas they are issued to students in only one school (1020*) in the other group of schools (see 7.3.4). This difference is reflected in patterns of frequency of use and where the textbook is used. Availability restricts the use of the textbook as a source of reference. A difference in the availability of resources for purchasing textbooks and teachers' attitudes concerning the use of textbooks, between these two groups of schools, is also reflected in section 7.3.4. If these differences in resource management account for the reported differences in student achievement, this research is further evidence in support of calls by the Chief Inspector of Schools [Ofsted 1996a paras 240-242] and others [Book Trust 1996] for increased expenditure on textbooks in schools.

Both the cloze task performance data and the average cloze task scores are further evidence for the proposition concerning the link between bilingualism and the understanding of scientific language discussed in section 7.4.4 based on the theoretical position put forward in Chapter 1 (see 1.2.6-1.2.7). The argument predicts that Schools 1004* and 1036* should demonstrate the *subtractive* effect of bilingualism. In each case the bilingual students involved do not form a diglossic community. The classes studied catered for students of all abilities and therefore any students held back by bilingualism are still included. At School 1004*, 24 bilingual students speak 18 languages. The bilingual subsample at School 1004* performed consistently less well than their monolingual peers in both cloze task performance and average cloze scores (*All differences statistically significant, diet using the Mann-Whitney U-test, kidneys and conservation using the t-test.*), despite continual access to the textbook, small classes and general high student approval. Cloze task performances in this school were generally higher than in other schools catering for students of all abilities, indicating that other factors such as student motivation had not influenced the results. At School 1036*, 18 bilingual students speak 9 languages. The cloze task performances at this school were similar to those for other schools using the textbook with students of all abilities. However, average cloze scores were consistently less good for the bilingual subsample than for their monolingual peers (*differences for diet not proven, kidneys and conservation statistically not significant*).

The bilingual students at Schools 1018* and 1020* are discussed in section 7.4.4. They are comparable samples which provide a comparison between a diglossic community (1018*) and a cosmopolitan community (1020*). Both samples consist solely of students from the top 39% of students in terms of ability in science, a group which was shown earlier to produce consistent cloze task performances and average cloze scores in a school with less than 10% bilingual students. It was decided to compare whole bilingual communities rather than Gujarati communities. There are several Kutchi speakers at School 1018* who could be included or excluded as Gujarati speakers (Kutchi is considered by some speakers to be a separate language, but by others to be a dialect of Gujarati [CILT 1985 p.3]). Without speaking to students in these languages (which was not possible) it would be very difficult to assess this distinction. It was also possible that some of the students who had identified themselves as Gujarati speakers might be included as Kutchi speakers within this fine distinction. Community benefits might well spread further than the Gujarati community. Some English students were interviewed at School 1018* who were learning Gujarati from their friends in order to use the language in the playground. Some speakers of other languages had increased in confidence with their own language through contact with the Gujaratis. The brief follow up questionnaire study (see 7.4.4) confirmed that School 1018* was a more diglossic community than School 1020*.

In the cloze task performance and average cloze scores analysis, data from these schools were compared with data from School 1010 which has less than 10% bilingual students. Students at all three schools do less well than students at selective schools. Students at School 1018* did better than those from the other schools at the diet and kidneys extracts (*not proven*) but least well on the conservation extract (*For 1010 difference statistically significant with F-test with a broader range of cloze scores at 1010. For 1020* difference statistically not significant*). Students from School 1020* did less well than students from 1018* on the diet and kidneys extracts (*not proven*) but similarly those to from 1010 on these extracts (*not proven*).

Figure 7.6 and Tables 7.h, 7.i, 7.j showed a tail off in cloze task performance and average cloze scores below the top 39% of students in terms of ability in science. The samples from Schools 1018* and 1020* fall within this top 39% of students in terms of ability in science, within which cloze task performance and average cloze scores were shown to be consistent. Although the sample from School 1010 consists of the more able students in the school it represents more than half the school population and thus includes student who fall outside the top 39% of students in terms of ability in science. One might expect cloze task performance and average cloze scores to be less consistent in this school. Five classes at School 1010 share a single class set of textbooks. The textbooks are issued to students at School 1020* throughout Key Stage Four. At School 1018* the textbooks are more available than at School 1010, but are not issued to students. Many of the students at School 1020* had completed projects based on the diet extract, and so were familiar with that part of the textbook studied. It is not surprising therefore, that they performed slightly better than students from School 1010 on this extract (*not proven*). Any advantage was cancelled out when they attempted the kidneys extract (*not proven*). The monolingual students at School 1010 produced the best cloze task performance on the difficult, conservation extract (*The differences were statistically significant using the F-test. The bigger variances for the data from School 1010* indicates a broader range of scores in this data.*). 21 students at School 1010 understood this extract compared with 1 at school 1018* and 5 at School 1020*.

The argument put forward in Chapter 1 (see 1.2.6- 1.2.7) predicts that the bilingual students at School 1018* should perform better than their bilingual peers at School 1020*. The average cloze scores indicate that bilingual students at School 1018* did perform better than those at School 1020* at the diet and kidneys extracts and achieved a similar standard at the, more difficult, conservation extract (*The differences between the diet and kidneys data sets were statistically significant using the F-test. The bigger variances for the data for diet and kidneys from School 1020* indicate a broader range of scores in this data. Using a t-test there is no significant difference for the conservation data.*). The statistical findings for diet and kidneys express the intuitive inference using the theory that there would be less variance in a sample from a single diglossic community compared with a diverse cosmopolitan bilingual community. The similar variances for the conservation data shows a more restricted range of scores for both samples when tackling a more difficult linguistic task. One might conclude from this evidence that diglossia confers an advantage in understanding scientific language but that any advantage is not as effective when students tackle difficult passages. In that case they achieve as bilingual students from cosmopolitan communities.

The bilingual students at School 1018* performed slightly better than their monolingual peers (*a very small subsample of 10 students*) at the diet, conservation (*statistically not significant*) and kidneys (*not proven*) extracts. The bilingual students at School 1020* performed slightly better than their monolingual peers at the diet extract (*statistically not significant*). This was the extract which 52% of students at School 1020* remembered having read before (See Chapter 6, Table 6.6 in 6.3.5), the figure compares with 1.4% for School 1018* and 5.5% for School 1010.). The bilingual students at School 1020* performed less well than their monolingual peers at the kidneys extract (*statistically no significant difference*) and similarly at the conservation extract (*statistically no significant difference*). Students suffering seriously from the subtractive effects of bilingualism might not be selected for these higher ability sets in science.

Treating each extract as a separate case, in five out of six cases, the two bilingual samples from selective schools (1021*, 1031*) performed similarly to the monolingual samples from those schools (*not proven in three cases, statistically no significant difference in two cases*). However, the bilingual subsample at School 1031* performed less well than their monolingual peers on the conservation extract (*statistically significant difference using the t-test*). These findings agree with the argument put forward in Chapter 1 (see 1.2.6- 1.2.7). The schools are cosmopolitan communities (43 students speak 21 languages at School 1021*, 30 students speak 17 languages at School 1031*). So one would not expect to observe the effects of diglossia. Students suffering seriously from the subtractive effects of bilingualism might not get selected for these schools. However, of those present, more bilingual students than monolingual students at School 1031* struggled with the conservation extract. Although the students in selective schools generally performed better than those in selected sets in schools catering for students of all abilities, there is some consistency in these comparisons between bilingual and monolingual subsamples in these two groups of schools.

If the theory of *elitist bilingualism* put forward in Chapter 1 (see 1.2.5) holds, one might expect bilingual students at School 1004* which is an international school and School 1021* which is an English boys' public school to perform better than their monolingual peers. In fact the bilingual students at School 1004* perform significantly less well that their monolingual peers (*The differences for diet were statistically significant using the Mann-Whitney U-test, kidneys and conservation statistically significant using the t-test*). Bilingual students at School 1021* performed in a similar way to their monolingual peers (*diet not proven, kidneys and conservation statistically no significant difference*). There is no evidence in the data for elitist bilingualism.

7.6 Student interviews and discussion task data analysis

The reasons for choosing students' questionnaires and cloze tasks, rather than students' interviews, to collect data about the accessibility of the textbook studied are discussed in Chapter 4 (see 4.3). Questionnaires are an effective, time saving, research methodology. However, as Cohen & Manion [1989 p. 308] point out, questionnaires are a less direct means of collecting data than interviews. The desirability of *triangulation* between research methodologies in order to strengthen the validity of the data collected was discussed in Chapter 4 (see 4.4). In order to facilitate triangulation, a limited number of interviews were carried out with students at School 1039* in order to test inferences drawn from the data. The data collected through student interviews are presented as Table 7.1 in Appendix E.

School 1039* is described in Appendix A. This school did not take part in the main research study. Various changes in personnel and courses made it impossible to carry out this follow up work in any of the schools in the original sample with more than 10% bilingual students. It was desirable to interview some bilingual students bearing in mind the importance to the research of findings concerning bilingual students. School 1039* is an established school where the Science Department has used Nuffield Co-ordinated Sciences courses successfully for several years. It is a comprehensive school where all the students in the year group studied follow Nuffield Co-ordinated Sciences courses. About 10% of the school population is bilingual. The majority of those students who are bilingual, speak Asian languages and includes some students who speak Gujarati. In School 1039* students are setted in science within two half years, each of which includes students of the full range of ability in science on the criterion of ability in science as assessed through test results and teacher recommendations. The textbook studied was not issued to students following the Nuffield Co-ordinated Sciences Double Award course and was only used in the coverage of a limited number of particular topics with these students. *Biology for Life by D.G. Mackean* was the textbook more generally used by Double Award students.

As access to students was limited, it was necessary to focus the interviews on particular aspects of the study. It had already been possible to draw comparisons between data obtained through cloze task analysis and readability analysis (see 7.5.6). Data obtained through the students' questionnaire concerning the use of the textbook studied had been compared with that obtained through teachers' interviews and questionnaires (see 7.4-7.4.4). Consequently, the interviews focused on the second part of the students' questionnaire, the section where students commented on their attitudes to the textbook studied and their opinions of it. The data collected through the students' questionnaire concerning these issues, which are crucial to textbook accessibility, had not been compared with similar data obtained through alternative methodologies. Interviewing is an appropriate technique to use when probing attitudes and opinions [Cohen & Manion 1989 p. 308]. The second section of the students' questionnaire was of added interest as the section where students had been encouraged to record observations made to the researcher and teacher researchers as discussed in Chapter 6 (see 6.3.1). The open-ended nature of the questions in this section of the students' questionnaire may have led to a more subjective form of analysis which should be tested by *triangulation*. The questions used in the students' questionnaires were also used in the interviews in order to make the data sets directly comparable.

Two groups of Year 11 students (these students were one term older than those taking part in the main study) were interviewed during the Autumn term of 1996. These were a group of four bilingual boys and a group of four girls, one of whom was bilingual. These students are members of science sets falling in the *middle third* of sets in terms of ability in science as assessed by test rest results and teacher recommendation. It was established in section 7.5.1 that many students falling below the top 39% of students in terms of ability in science do not to read the textbook studied at the independent or instructional levels. Consequently, one might expect the two groups of students studied to have difficulty in understanding and using the textbook studied.

The two groups of students put nine phrases concerning choice of science textbooks set out Chapter 6 (see 6.3.2) into similar orders of priority (see Table 7.1 in Appendix E). *The use of clear language* and *A clear structure to the whole book* came out at the top, and *Attractive design* at the bottom, of both lists. *Science in everyday contexts*, a particular theme of the Nuffield Co-ordinated Sciences philosophy discussed in Chapter 2 (see 2.6.4) came third from bottom on both lists. The most noticeable difference between the lists of priorities was that *A glossary* which was ranked third by the group of four bilingual students was ranked next to last by the group which included just one bilingual student. This finding may indicate that glossaries are particularly useful to bilingual students (see Chapter 3: 3.3.3, and this chapter: 7.3.3). However, further work would be needed in order to establish this.

The data concerning students' responses to questions concerning their attitudes and opinions to the textbook studied will be discussed in conjunction with data collected through a discussion task. As explained in Chapter 6 (see 6.2.2) this discussion task was administered to Year 10 students at School 1020* during the pilot study in May 1993. Excerpts from the data collected are presented as Transcript 10201 in Appendix B. These data consist of extracts from a transcript of recordings made at School 1020* of students' conversation whilst working on a discussion task involving an passages from the textbook studied (see 6.3.8, Appendix D). Two of the four girls who participated are bilingual (one speaks Gujarati, the other speaks Arabic). All four students were members of a science set made up of the most able students in science in their year as assessed by teacher recommendation and test results. The text used for this discussion task included part of the conservation extract discussed in the cloze task analysis presented earlier in this chapter (see 7.5- 7.5.6). It also included the next page of text in the textbook studied (see the copies of the texts used for both tasks included in Appendix D). Appendix B also includes copies of the responses made by each of these students in the second section of the students' questionnaire. As explained in Chapter 6 (see 6.3.8), the first part of the cloze task extract was unsuitable for use as a discussion task. One should bear in mind throughout this analysis that the discussion task data concerns an extract from the textbook studied which was shown in the cloze task analysis (see 7.5.6) to cause students more difficulties in understanding than extracts about diet and the kidneys. Their allocation to science sets indicates that the students from School 1020* who participated in the discussion task are more capable in science than those studied from School 1039* who were interviewed. This difference in science capability should be taken into consideration when comparisons are made between the two data sets.

One group of students interviewed responded to the question "*Do you like using the Nuffield Co-ordinated Sciences Biology book?*" negatively, the other with slightly more enthusiasm. This finding agrees with findings from the analysis of the students' questionnaire responses from similar *middle third* sets (see School 1035 sets 03, 04, 05, School 1029 sets 3, 4, Table 7.b Appendix E). The reasons for disliking the textbook studied given by the students interviewed concerned difficulty in understanding the text rather than inadequate coverage of content.

"*It's too hard to understand*"

"*There should be more writing about the diagrams*" (Group A)

"*The questions are easier to understand in Biology for Life*"

"*Sometimes I don't understand what it's saying*" (Group B)

This finding is similar to findings from the analysis of the students' questionnaire responses reported in section 7.3.3 and the findings from the cloze data analysis reported in section 7.5.1 (see Fig 7.6) concerning similar *middle third* sets in terms of ability in science. There are several examples of misunderstanding of the meaning of the textbook studied in the discussion task data (see Transcripts 10201A lines 015-023, 10201B lines 135-160). It seemed that dislike of the textbook studied was more likely to be linked to misunderstanding of the text than to lack of detail.

"F *They don't go into much detail, do they.*

S *It's just as well. I don't understand it.*" (Transcript 10201A lines 017-018)

In response to the questions, "*Why do you feel like that about it?*" and "*What would make the book better?*" all of the responses given in the student interviews could be categorised using the categories set out in section 7.3.3. None of the students interviewed made responses which were listed under "*Other*", in the appropriate directory of responses. This finding provides support for the categorisation of the students' questionnaire data described in section 7.3.3 and the discounting of the data listed under "*Other* ", two strategies which were used in the analysis of that data. Extract E from Transcript 10201A is a discussion about the textbook studied (see Appendix B Transcript 10201A lines 615-688). The points made in the discussion such as,

"*It's not set out in a logical way. They jump, they jump from one topic to another*" (line 669).

"F *The pictures jump.*

S *They do, some of them are on the wrong sheets.*" (lines 675-678),

could be categorised using the categories set out in section 7.3.3. None of the discourse recorded included statements about the textbook studied listed under "*other*" in the appropriate directory of responses. These data thus provide further support for the categorisation of the students' questionnaire data and the discounting of the data described in section 7.3.3.

The data collected from the students' interviews concerning useful and difficult sections of the textbook studied were inevitably affected by the light use made of this textbook in School 1039*. However, the findings were similar to those from the students' questionnaire data analysis concerning similar *middle third* sets.

"*The whole book was pretty hard. The farming and agriculture was difficult, it didn't have enough information to answer the questions and it referred you to the Chemistry book.*" (Group A).

The discussion of helpful and difficult sections of the textbook studied does not appear in the transcript data.

The students interviewed did not criticise the quantity of information presented in the subject narrative of the textbook studied. However, they did make criticisms of the subject narrative of the textbook concerning the organisation of information and the difficulties experienced finding the answers to the questions posed in the text.

"*in the Nuffield book sometimes you've got to read a whole section to find an answer that's in the text*" (Group B)

The students' questionnaire data analysis identified similar attitudes to the subject narrative of the textbook within middle third sets in terms of ability in science (see 7.4.2). However, the students interviewed offered more comments and criticisms concerning the teaching discourse of the textbook studied than was generally offered by members of similar science sets in data collected through students' questionnaires. In the students' questionnaire data analysis it was suggested that there might be a loose link between students' reactions to the textbook's teaching discourse and its use within teaching strategies (see 7.4.2). The students interviewed were currently using the textbook studied as part of a programme of revision for school examinations. This programme involved answering the questions found in the textbook, an activity which relies on the textbook's teaching discourse. Consequently, assuming that the students' comment and criticism concerning the teaching discourse of the textbook studied were due to their experience of recent classroom tasks, this finding also agrees with findings from the students' questionnaire data analysis.

"*It's really hard to revise from because it gives you just information and questions. Make it easier to revise from by having questions at the end of each chapter and at* *the end of the book with answers.* " (Group A)

The students interviewed compared the textbook studied with *Biology for Life* with which they were more familiar.

"*there are other books like Biology for Life with easier questions. Biology for Life is better written. The questions are easier to understand in Biology for Life. The language in Biology for Life is simpler. The questions in Biology for Life are like mini assignments at the end of a chapter.*" (Group B)

"*It should be more like Biology for Life with tests at the end of each section so that you know what you're doing. You can test yourself*"

"*Biology for Life is better because it has larger diagrams which are generally relevant for the work.*" (Group A)

The students interviewed felt that the questions in a textbook should give students practice in answering examination questions. They suggested that the questions in the textbook studied would be more useful for revision if they helped the student to check the extent of their knowledge and helped to identify areas of weakness.

The transcript data included criticism of the explanations presented in the subject narrative and the order in which information is presented in it.

"*I mean it's in the book it jumps from the animals to the forest again and then to other animals and...*" (Transcript 10201A lines 621-622).

"*They' re really contradicting themselves with this, aren't they?*" (Transcript 10201B lines 108-109).

There were no references to the teaching discourse of the textbook studied in the discussion task data.

The students interviewed were critical of the language and communication aspects of the textbook studied. This finding agrees with findings from the students' questionnaire data analysis (see 7.3.3). Four of the five bilingual students interviewed suggested that this textbook should have a glossary. The students interviewed agreed that the language of the textbook studied was difficult to read and understand. They were also critical of the structure of the textbook as were the students taking part in the discussion task quoted above.

"*I don't think the way the chapters are set out is very good. They could be better organised. There could be a section at the back which helped you with the questions without actually giving you the answer.*" (Group B)

The students interviewed commented that questions should come at the ends of sections and that each chapter should close with a summary (see also Chapter 2: 2.5.4). They suggested that the textbook should include answers to questions, guidance in answering questions or directions to answers to questions in the text. They found references to the companion textbooks unhelpful and exasperating. The criticism of the figures in the textbook studied by the students interviewed agrees with findings from the students' questionnaire data analysis (7.3.3). The students interviewed went on to explain the difficulties which arise from irrelevant or inadequately explained figures.

"*I don't even look at the pictures unless they're related to the work........ I don't need to know what Charles Darwin looked like. There should be more pictures like the leaf sections.*"

This statement agrees with research findings reported in Chapter 2 (see 2.4.1) concerning the relationship between pictures and text.

The students interviewed advocated the use of large clear diagrams and the greater use of colour (see also Chapter: 2.4.1).

"*The diagrams could have been made bigger and some of the cartoons and photographs could have been left out all together. Large irrelevant photographs could have been replaced with useful diagrams.* " (Group A)

The findings from the analysis of the data collected through student interviews and discussion tasks confirmed, complemented and extended the students' questionnaire and cloze task analyses concerning the attitudes and opinions of students. The findings demonstrate the importance of appropriate figures, language and structure in school science textbooks. This triangulation between methods of data collection provides further evidence in support of some of the findings reported in this chapter.

7.7 Summary

The chapter set out an analysis of the data collected during the research study. Data was collected through interviews, questionnaires, a cloze task and a discussion task. Although the data collected through these methods differed in many respects, the data sets complemented one another. Conclusions gained from one data set were supported by evidence derived elsewhere. A statistical analysis was carried out on the cloze task data.

The data analysis provided evidence for the argument concerning the effect of bilingualism on the understanding of scientific language set out in Chapter 1 (see 1.2.6, 1.2.7) which resolves the research questions set out in Chapter 4 (see 4.2), concerning the accessibility of science textbooks to bilingual students. The major inferences arising from this data analysis were endorsed by the statistical analysis. The argument put forward the proposition that bilingualism within diglossic communities produced additive effects on accessibility and that bilingualism within cosmopolitan communities produced subtractive effects on accessibility. However, there was no evidence in the data to support the theory of elitist bilingualism put forward in Chapter 1 (see 1.2.5). Scientific language skill was shown to be a general skill which is not particularly dependent on lexis, grammar or genre exclusively. Competence in these components of language was shown to develop concurrently. Advantage or disadvantage due to bilingualism was demonstrated as a general skill which was not particularly dependent on or affective to any one of these semiotic planes. This discussion linked with Chapter 3.

It was shown that gender did not have an important effect on the student approval of this particular text and that student approval was not a good indicator of student understanding (linking with Chapter 2). The reasons for the relative difficulty of the conservation extract, as demonstrated by cloze task performance, were discussed in terms of grammatical difficulty, text cohesion and usefulness of figures. This discussion linked with the analysis of the cloze texts included in Chapter 6 and the critique of the textbook studied included as Chapter 5. The analysis also included a discussion of the availability of textbook resources in schools and its effect on textbook understanding. These findings and conclusions will be developed further into a discussion of the implications of the research and recommendations for action in Chapter 8.

Chapter 8: Implications and recommendations

8.1 Introduction

This critical review of the research study is written from three perspectives, the evaluation of the work, the implications of the research findings and recommendations arising from those research findings including suggestions for further research. The review will discuss the success of the research in examining the accessibility of school science textbooks to bilingual students.

The main research questions discussed in Chapter 4 (see 4.2) were,

* Do monolingual and bilingual students have the same problems with school science textbooks?

* Is bilingualism an advantage or a disadvantage to students dealing with school science textbooks?

The research findings suggested that monolingual and bilingual students had similar difficulties in understanding school science textbooks. The findings also indicated that in some circumstances bilingualism is an advantage in understanding school science textbooks whereas in others it may be a disadvantage. Various implications concerning *school science textbooks, the use of these textbooks* and *resource management* arise from these and other findings discussed in earlier chapters. Some of these issues were raised as part of the discussion in Chapter 7. Other issues arose from the analysis of the textbook studied (see Chapter 5), and the theoretical positions set out in Chapters 2 and 3. Throughout the chapter schools with more than 10% bilingual students are indicated by an asterisk*.

8.2 Findings, reliability and validity

The students' and teachers' questionnaire and interview responses and the students' performances on the cloze task confirmed that many students do find school science textbooks inaccessible. These findings are consistent with the earlier research described in Chapters 2 and 3 (see, for example Perera's work described in 2.3.1 & 2.3.4). The evidence collected, including the analysis of the textbook studied (see Chapter 5), showed that the textbook studied was inappropriate for many students. The extract from the textbook about conservation was identified as particularly difficult for students. A grammatical analysis, linked with features identified and discussed in the earlier chapters, accounted for this added difficulty. Students and teachers also identified difficulties with the textbook studied in their questionnaire and interview responses which linked with other research reported in Chapters 2 and 3. The difficulties experienced by students were investigated through analyses of their questionnaire responses and interviews, their performance on a cloze task and a discussion task and comparisons drawn between the contributions made to average cloze scores by lexis, grammar and genre language components. It was concluded that generally, bilingual and monolingual students have the same sorts of difficulties with science textbooks. However, in different circumstances, the bilingual students performed better or less well than their monolingual peers.

It was shown that bilingualism may be an advantage within diglossic language communities (e.g. School 1018*), where the second language community is large enough, and bilingualism is extensive enough, that speakers have many opportunities to select from their languages for particular purposes within the school and community. In these circumstances bilingual speakers are likely to switch between languages depending on the content of the conversation. Bilingualism was shown to be a disadvantage in some cosmopolitan bilingual communities (e.g. School 1020*), where the second language community is one of several smaller language communities. In these circumstances bilingualism is not extensive enough for speakers to have many opportunities to select from their languages for particular purposes within the school and community. In these situations bilingual speakers are likely to converse in one or other of their languages depending on the language competency of the people they are talking to.

The *reliability* of the evidence collected was enhanced by the size of the survey undertaken. Sixteen schools were visited and over 1500 students, including 272 bilingual students, completed the research tasks. Speakers of over sixty languages took part in the research. The sample studied included whole year groups of students. Half of the schools in the main sample had more than 10% bilingual students. However, the sample, particularly the bilingual students, was biased towards students of average and above average ability. Very few bilingual students in language acquisition took part in the study. The reliability of the data was further strengthened through the collection of several types of data in order to address each research question, thus facilitating triangulation between data sets as discussed in Chapter 4 (see 4.4). The research documentation including protocols, procedures and interview schedules, was designed to improve consistency in data collection. For the same reason, the cloze task was offered to students in three orders of extracts, in rotation. However, data collection was spread out over a period of three years, various teachers assisted in data collection and the length of time available in lessons varied between schools. Time allocation to the biology part of the course also varied between schools. For this reason, and in order to reduce the number of visits required of the researcher, some classes attempted the research tasks during periods when they had not studied biology for several weeks or during lessons designated for physics or chemistry. Sometimes the teacher present was not a trained biologist or the class's regular teacher. These factors may have affected students' attitudes to the research and their performance on research tasks.

Various steps were taken to ensure the *validity* of the data collected. The school profiles were checked by Heads of Science in the schools concerned and any amendments suggested were automatically included. Students were encouraged to record observations made to the researcher in their responses booklets and throughout the study a tape recorder was available to record comments made by teachers and students. The research instruments were trialled during a pilot study which included a discussion task attempted by four students. The research instruments were subsequently reviewed and amended. The cloze task was made as similar as possible to the textbook itself. One reason for selecting the cloze technique was that it is long established and has been matched against agreed American standards. The cloze technique also mirrors the *short bursts* pattern of reading characteristic of science classrooms discussed in Chapters 2 and 6 (see 2.3.2, 6.3.4). The cloze procedure is a relatively straightforward form of task which can be explained to groups of students quickly and effectively. However, one might question whether the cloze technique gives a true picture of the capability of those students who find reading, writing or understanding difficult. Although the cloze task is similar to some classroom tasks, only four of the schools studied used it as a regular teaching strategy. The use of questionnaires and a cloze task as research methodologies restricted the amount of data collected directly from students. However, students were encouraged to record verbal responses and some students were interviewed towards the end of the study in order to check the inferences made from the data collected using more impersonal techniques.

8.3 Reflection and evaluation

With the benefit of hindsight, the author might have organised the school-based research work slightly differently. Perhaps more schools should have been included at the pilot stage. The pilot study could then have been used as the basis for selecting schools for the main research, as well as a means of testing out research instruments and procedures. If a larger group of schools had been screened at this stage, it might have been possible to use a smaller group of schools, which were more similar in terms of school populations and setting arrangements, for the main research. The author was certainly surprised and disappointed by the fact that variation in setting policies in the sample of schools studied reduced the scope of comparisons between classes in different schools. On the other hand, an alternative approach might have restricted the scope of the study.

The limited investment in well produced materials, which were professionally presented, was money well spent. These materials gave the research a certain professionalism and credibility with all those taking part. It is a sign of the times that, in these days of desk top publishing, presentation is very important. The involvement of the Nuffield Chelsea Curriculum Trust, and later of the Nuffield Foundation, was a great help to the research. The use of their headed notepaper for initial contacts was invaluable. The author is convinced that the credibility provided by the Trust and the Foundation was the main reason why initial contacts were so successful. The school profiles proved to be a valuable resource throughout the research and informed the analysis of data. However, they could have been organised slightly differently. During the course of the research it became apparent that Ofsted inspection reports and school prospectuses were useful documents when compiling such brief descriptions of schools. Ofsted reports and school prospectuses have to include certain information by law and include other information through custom and practice. They therefore contain standard categories of information. The profiles could have been made more structured so that this information was presented in a way which made it easier to compare schools with one another.

A potential limitation of the research methodology was in the area of *evaluation* and *moderation*. The researcher originated the research instruments and administrative documentation such as protocols in addition to his role in administering the research tasks and analysing the results. Various strategies were adopted to reduce the effects of this potential weakness in the research. The research instruments, documentation and coding of data were discussed with colleagues at the Institute of Education through tutorials, research seminars and informal discussions. A paper concerning the research methodology [Kearsey 1994], was also presented and discussed at a European research summer school. INSET based on the research tasks and documentation was carried out in some study schools and the research tasks were used with students at the Institute of Education and De Montfort University. These sessions provided additional feedback and comment. The research was discussed with the people involved in writing and producing the textbook studied and with teachers using the textbook studied in schools not involved in the research study. The author was involved in writing syllabuses and activities for this course during the research study and used consequent contacts and meetings to discuss the research.

Wherever possible, the regular teacher of a class was present during the administration of the research tasks and, in some cases, teachers were trained to administer the research tasks. A research assistant who is a very experienced teacher involved in a different phase of education was also trained to administer the research tasks. The research instruments and methodology were discussed with these teachers and with others who took part in the research both prior to, and following, the administration of the research tasks. These conversations were taped and analysed. Teachers were also given opportunities to comment through teachers' questionnaires. These teachers acted as the moderators and evaluators of the research. The researcher was also able to evaluate and moderate the research in circumstances where it was administered by a teacher researcher. Discussions with students involved in the research, which were taped and analysed, provided valuable feedback concerning the research instruments and methodology.

The documentation produced during this study, the interview schedules, protocols and directories of responses were an important aspect of the research. This documentation ensured consistency in approach and quality control over the four years of the work. The documentation was strictly adhered to. For instance, the protocol was used exactly as described in every classroom studied. The documentation provided a focus for training the research assistant and teacher researchers. The documentation ensured that all students were provided with the same experience during the course of the study and that the coding of responses was consistent over the period of the analysis of results. This consistency and quality control was essential to both the reliability and the validity of the data presented. The documentation also provided valuable reference material during the writing up of the study as a verbatim account of what happened in every classroom studied. Complementing the documentation, record keeping, filing and notetaking made useful contributions to the study. The organisation of the project and the relationships with schools were successful. On a personal note, it was very refreshing to find so many enthusiastic teachers and students in schools during a period of considerable pressure and change. Visiting the schools and studying organisation and practice in detail, were personally, professionally enriching experiences.

8.4 Implications of the study

As far as the author is aware this is the first study of its kind to deal with bilingual access to a major secondary school science textbook. When considering the valuable resources which bilingual students bring to the classroom, this study included linguistic resources alongside the cultural and contextual resources considered by other studies [e.g. Thorp 1991, Thorp, Deshpande & Edwards 1994, Ditchfield 1987]. Most readability studies [e.g. Dangerfield 1981, Graham 1978, 1981] involved groups of less than 150 students who were either monolingual or whose language capability was not stated. A study of bilingual students' access to secondary school science textbooks [Letsoalo 1996] did not compare monolingual and bilingual performances. Dangerfield [1981] and Graham [1978, 1981] used readability formulae or cloze techniques. However, none of the studies reviewed combine these techniques with questionnaire studies and the consideration of detailed information about the schools studied in the form of school profiles, in the manner of this research.

Although there is a literature on the additive and subtractive effects of bilingualism on cognition which was discussed in Chapter 1 (see 1.2.6), an extensive review of the literature did not uncover any studies which demonstrated the additive and subtractive effects of bilingualism on scientific, or any other form of language. The studies on cognition were theoretical [e.g. Cummins 1976] and did not present research evidence supporting the theory of additive and subtractive effects as demonstrated in this study. Although Bormuth [1965, Bormuth & MacDonald 1965] conducted studies using the cloze technique to look at grammar, semantics and literary style, he used percentage correct scores or assigned responses to each gap to categories. As far as the author is aware, the present research is the first time that cloze scores have been broken down into lexis, grammar and genre components. This may be the first time that consistency in the contributions made by these components to cloze scores has been demonstrated.

The findings have important implications for the use of school science textbooks with bilingual students. The demonstration of a possible additive effect of bilingualism supports the argument put forward by several authors discussed in Chapter 1 (see 1.2) that bilingualism should be treated as a resource in the classroom. This finding supports the practice of developing bilingual and bicultural links with the community and countries of origin in multicultural schools (see Appendix A, School 1018*). The subtractive effect of bilingualism was demonstrated amongst students of high social class, possibly demonstrating that this is a linguistic effect rather than a social class effect. The finding that bilingual students did not have particular language problems suggests that it should be possible for science teachers to raise the scientific language capability of these students without specialist assistance. As in any consideration of mixed ability within classes, differentiation of material is an important issue in these situations.

8.5 Bilingualism and school science textbook accessibility

The findings indicated that some bilingual students may perform as well, or better, than their monolingual peers on simple tasks involving understanding text taken from a school science textbook. There was some evidence to show that bilingual students who lived in an environment dominated by one second language (School 1018*) were at an advantage compared with similar bilingual students living in a more cosmopolitan environment (School 1020*). The author argues that the use of two languages for various purposes, or diglossia, provided the bilingual students in the group dominated by one language with a *linguistic awareness* which helped them to understand scientific language. However, this advantage broke down when the students tackled a difficult passage of scientific writing. This effect was attributed to a lack of familiarity with complex grammar and sentence construction. Evidence obtained from samples of students of a wide range of ability, including bilingual students speaking various languages, suggested that some of these bilingual students were at a disadvantage compared with their monolingual peers. The author considered this effect to be due to *linguistic interference* between their two languages. When the scientific language of textbooks was broken down into lexis, grammar and genre, the patterns of performance of bilingual students were similar to those of their monolingual peers. This suggested that the advantage or disadvantage conferred by bilingualism had a general effect on the understanding of the scientific language of textbooks.

There was evidence of differentiation in teaching strategies between classes and the acknowledgement amongst teachers that the textbook was mainly for able students. However, there was no evidence of an understanding amongst teachers of the need for a differentiated approach within classes of similar *scientific ability* due to differences in scientific language capability resulting from the additive and subtractive effects of bilingualism.

The group of students from a bilingual population dominated by one language, which demonstrated the positive effects of diglossia, were selected students of higher ability in science. They included a larger proportion of girls than the comparable general school population. It thus seemed possible that gender might be a factor in the suggested positive effect of diglossia. Unfortunately it was impossible to pursue this line of enquiry further within the current study.

8.6 Textbook production and classroom practice

The research findings have general implications for textbook production and for classroom practice involving the use of textbooks. Although the textbook studied was criticised by the author, it was found to be popular with many students and teachers and had some commendable features. Work began on the textbook studied in 1986. The intervening years have seen many changes to science teaching and textbooks. Chapter 5 (see 5.1-5.2.6) chronicled the introduction of, and subsequent changes to, the National Curriculum for Science. The discussion in Chapter 7 (see 7.3.4, 7.4.3, 7.5.6) and the school profiles (see Appendix A) revealed a squeeze on the availability of resources in state schools during this period with an inevitable impact on book purchase, class size and teacher availability. In addition, advances in information technology have had a direct impact on textbooks, the writing of textbooks, and textbooks in use. Publishing in the nineteen nineties involves greater use of desk top publishing than publishing in the nineteen eighties did. Books are now produced more quickly and cheaply. As Cameron [1995 p. 36] points out, one effect of modern technology has been that authors have become more responsible for their own editing. Nineteen nineties book design, on computer, enables exciting new forms of presentation and forces costs down. The increased availability of CD-ROM and multi media technology has brought the continuing role of textbooks in the classroom into question. This effect is evidenced by suggestions from students taking part in the study discussed in Chapter 7 (see discussion of comments listed under *Other* in 7.3.3). This period of dramatic change is the context against which to consider any general implications of the research.

The figures in the textbook were consistently criticised by students taking part in the study. Some evidence indicated that diagrams which actually helped to explain scientific lexis were more useful to students than purely illustrative figures. As explained in several chapters (see 3.4.1, 6.3.6, 7.5.6), scientific diagrams could be helpful to students in this respect. It was pointed out in Chapter 5 (see 5.2.5) that the illustrators, writers and designers involved in the production of a textbook do not necessarily work closely together and consult one another. One of the effects of modern technology on work practices in publishing is to increase the independence of the individual members of a team working on a textbook. Commissioned photographs are more expensive than those obtained from picture libraries and illustrations may be obtained by non-specialist picture researchers working to picture briefs. Consequently, figures tend to loosely match a written text rather than complement it properly. A study of figures involving images of people discussed in Chapter 5 (see 5.4.1-5.4.2) revealed a lack of positive images of non-white people in this textbook. However, it was acknowledged that picture library sources of positive images of non-white people were limited.

As discussed in Chapters 6 and 7 (see 6.3.5, 7.5.6) a majority of the students involved in the research found the extract from the textbook studied on conservation (section B18.2) difficult to understand. This difficulty might have been due to lack of cohesion, difficult grammar, long sentences, poor text organisation, lack of the prior knowledge assumed in readers, or a combination of these factors. Alternatively it might be linked with a lack of co-ordination between figures and written text. Surprisingly, the extract in question scored a low reading level calculated using a readability formula. The difficult extract included relatively less scientific lexis than the other two extracts used. This demonstrated the role played by grammar and sentence length in the difficulty of understanding science text.

In the two schools (1036*, 1020*) where student approval was highest (over 80%), and in a special school where students liked the textbook, cloze task performances were poor in some classes (At Schools 1036* & 1020* half the classes had cloze average scores at the frustration level for the diet extract). This indicated that student approval might not be a good measure of text accessibility. Although the textbook studied was intended for use with all students it was found that less able students liked it less and performed less well on tests of accessibility based on it. On the other hand, some of the most able students found the textbook inadequate in terms of depth of content. One might conclude that it is doubtful whether it is possible to produce a textbook which is suitable for students of all abilities. One of the effects of the National Curriculum has been to rationalise curriculum content so that, in future, all textbooks will cover the same content. There will, however, be differences in the depth of treatment. Consequently, it may be more common in the future for textbooks to be used in combination, or for particular textbooks to be used with particular groups of students (School 1021*, where different combinations of textbooks were issued to different groups of students, achieved excellent examination results, see Appendix A.). It will also become more common in future for material to be written with built-in differentiation as a matter of course. Another force in this drive towards differentiated material is the emphasis placed on differentiation in Ofsted inspections [see Ofsted 1996b pp. 34-35].

8.7 Recommendations

For recommendations to be effective they need to be directed to specific groups of people who can effect change. The main groups of people effecting change in textbooks and their use are those producing textbooks, teachers using textbooks, and policy makers who manage resources, including textbooks, in schools. Teachers and policy makers, as those who implement the curriculum, are in a better position than authors to effect change in the way textbook resources are used. Paradoxically then, for recommendations to be effective, a new market must be created to which individual authors can respond. In this author's opinion, the misdirection of criticism, on individual authors as a textbook's figurehead, may account for the slow pace of textbook innovation.

8.7.1 Those producing textbooks

Publishers, writers and editors should consider bilingual students when developing and producing textbooks. Bilingual students need clear, concise, prose, which avoids difficult, unfamiliar constructions, and long sentences. It is possible to write in this way and yet still use the science register, as described in Chapter 3, enabling textbooks to fulfil the important role of introducing students to scientific language discussed in Chapter 2 (see 2.5.1). When simplifying scientific writing, it would be useful if authors and editors paid attention to the need to retain the precision and universality of Standard English and to avoid slipping into forms of common parlance which may cause more problems than they solve as discussed in Chapter 3 (see 3.2-3.2.2). Figures can be used in an intelligent way to complement text. Some of the bilingual students who took part in this research suggested that glossaries helped in understanding school science textbooks.

Those producing textbooks might consider ways in which written text could be more closely linked with figures in textbooks. This might involve facilitating more interaction between the various members of teams involved in the production of textbooks. If the house style manuals discussed in Chapter 3 (see 3.3.6) included procedures for writing artwork briefs, for artists and picture researchers, they might help to improve communication within the team and thus help to ensure a better match between written and graphic text. Images portrayed should reflect the multicultural society within which textbooks are used and should show non-white people doing useful tasks. By creating a demand for multicultural material from picture libraries, publishers could help to improve the availability of such material.

Textbooks would be improved if they were made consistent in terms of cohesion, grammatical difficulty and sentence length. This goal could be achieved through effective editing and through the use of house style manuals to implement stricter writing policies. The author argues that textbooks should be written in a simple style which avoids the use of complicated grammar and long sentences but which gives students some experience of the science register. An awareness of the messages regarding text context embedded in the structure of their writings, discussed in Chapter 3 (see 3.7.2), would help authors to write more sympathetically for students. Authors would then endeavour to make these messages simple, appropriate and straightforward to interpret. Textbooks should promote study skills in students through well organised, simple text layout and structure. Devices such as markers within text or as symbols in the margins of text also help to promote study skills.

Simple student opinion surveys are unreliable tools in the assessment of the effectiveness of textbooks. Readability formula analysis also has limitations. If textbooks are trialled, students should be given tasks involving the use of the textbook, such as cloze tasks. Such trialling is most effective when it is carried out near the beginning of a writing project to enable the findings to be incorporated into the final product. The research showed that textbooks should provide more differentiated material for students of different scientific language capability. Differentiation may be achieved through different activities based on the same text as discussed in Chapter 2 (see 2.5.4), through differentiated textbooks provided within the same resource (In the manner of Ginn's Challenge Science scheme for Key stage Three) or through different textbooks issued to individual students (School 1021*). Another approach worth attention is that adopted in newspapers and journals. Journalists tend to summarise a story within the first paragraph and then develop it further in later paragraphs. This form of writing echoes the use of Advance Organisers in textbooks discussed in Chapter 2 (see 2.5.3).

8.7.2 Teachers

As bilingualism may be an advantage in understanding scientific language, teachers should not automatically assume it to be a handicap. This positive effect is particularly likely to occur in situations where a large majority of students speak one particular second language within a lively ethnic community. The match between teachers' expectations and students' capabilities [see also Gilborn & Gipps 1996 pp. 54-57] is an important consideration in teaching bilingual students. Even advantaged bilingual students will have problems understanding difficult pieces of scientific text. Text should be selected for bilingual students with care. Science text for bilingual students needs to be challenging enough but not too difficult. It is therefore necessary to regularly check and record these students' level of understanding of text within school science textbooks. Even in setted or selective situations, teachers need access to a wide range of differentiated textbook materials to teach bilingual students effectively. In the author's view, students need instruction in the understanding and use of the science register alongside, well chosen, differentiated, textbooks and materials. Such an understanding should include skills in the interpretation of scientific figures and illustrations discussed in Chapters 2 and 3 (see 2.3.5, 2.3.6, 3.4.1) [see also Book Trust 1992 p. 36].

Readability formulae, although they might be useful as general indicators of text readability are not necessarily good indicators of the difficulty students have with certain science texts. An awareness of the difficulties which students experience in understanding science text which are associated with cohesion, grammar and sentence length would make teachers more effective in using these texts with their students. Student approval of a textbook does not necessarily imply accessibility or understanding. Student approval may be due to the familiarity of the textbook or a close match between classroom procedures and the textbook, rather than enjoyment or understanding on the part of the student. The provision of differentiated learning using textbooks could have a considerable impact on the range of resources which teachers require for individual lessons.

8.7.3 Policy makers

Policy is determined at a school level by the senior management and heads of department. Nationally, policy is determined by the Government and bodies such as SCAA and Ofsted. Various initiatives in School 1018* which have created links between the school and the Gujarati community and Gujarat are set out in Appendix A. These initiatives created an atmosphere where bilingualism was valued. The research findings indicate that such features of the school culture may foster an improved understanding of scientific language in bilingual students. Policy makers at the school level can encourage such initiatives through school policy and ethos statements and through positive action such as encouraging community use of the buildings, sponsoring community links and cultural activities and by providing instruction in community languages. National policy makers can encourage such initiatives through Ofsted inspections, curriculum policy and financial support. Bodies such as the Association for Science Education and the National Council for Mother Tongue Teaching also have a role to play in the promotion of good practice.

Differentiated learning using textbooks is only possible if sufficient financial resources are made available to teachers [see also Book Trust 1992 p. 20]. Those developing and implementing policy should be aware that teachers of bilingual students need a wide range of differentiated science textbook material and that they should be encouraged to check and record students' understanding of it. Teachers might find strategies developed to regularly check and record students' understanding of the science texts used helpful. Teachers in schools with large bilingual populations might find a policy for textbook selection, including checklists for textbook evaluation, helpful [see Ditchfield 1987, Thorp 1991]. Such checklists should include items on language difficulty and the usefulness of figures, as well as items on the multicultural nature of subject content.

8.8 Suggestions for further research

Similar studies of other comparable science textbooks, of textbooks in other subjects and of students of other ages would complement the findings from this study. The value of glossaries to bilingual students was raised during this research and should be investigated further. If glossaries are of value to bilingual students, this is a simple inexpensive modification which could be made to all textbooks. It would also be useful to find out whether gender is a factor in the linguistic advantage conferred on bilingual students by diglossia. Gender differences might link with differences in the amount of time spent in the home by boys and girls, or gender differences in the treatment of children within home culture. Alternatively, gender differences might be due to differences in the amount of time spent with relatives whose English is poor. Gender differences might reflect peer pressure or patterns of friendship. It is also possible that any gender differences reflect teacher perceptions of Asian students. The stereotypes of the quiet, demure, conscientious, Asian girl and the inattentive, lazy, Asian boy were mentioned in some of the interviews with teachers recorded for this research [see also Gilborn & Gipps 1996 p. 56-57].

The work on diglossia in this research involved Gujarati, an Indian language. In the light of the research reported in Chapter 1 (see 1.2.8), concerning the educational achievement of bilingual students at GCSE, it would be worthwhile to extend the research to studies into the effects of diglossia in other Asian communities from India, Pakistan and Bangladesh. Such studies might involve languages such as Bengali, Hindi, Panjabi and Urdu. It might be interesting to compare these studies with further studies involving speakers of creoles, patois and English dialects. In the light of the Gilborn and Gipps [1996] review of research in the area, such studies should take social class into account.

It would also be worthwhile to follow up the findings concerning figures in text. First, the relationship between figures and written text could be investigated, in particular the role of figures in defining technical terms. Secondly, the reasons for consistent student disapproval of figures in the textbook studied and the differences between students' and teachers' attitudes could be probed further. Such a study could be linked to the process of textbook selection. The need for differentiated textbook materials has been demonstrated in this chapter. The whole question of providing differentiation in school science textbook materials is important and worth further study. The various approaches suggested above could be evaluated and compared. It would be worthwhile to do some work on the provision of differentiated textbook materials through CD-ROM and multi-media forms of presentation. One of these approaches might be found to be particularly appropriate for use with bilingual students.

8.9 Summary

This chapter has set out an evaluation of the study and the implications of the research. Consequently, recommendations were made for action and suggestions for further research were discussed. It was shown that bilingual students do not require particular consideration in terms of the language of textbooks. However, the case was put for clear, concise school science textbook materials and the need for differentiation in school science textbook materials in use. Such textbooks and classroom practice would be of benefit to all textbook users. Bilingual students require special consideration in terms of differentiation of materials within classes even if these consist of students of similar scientific ability. The provision of these resources has financial implications.

The case was also made for teachers to reflect on their attitudes towards bilingual students and their capabilities. Policy makers in schools with high proportions of bilingual students were urged to consider cultural links with local ethnic communities and countries of origin. Policy makers in these schools were also encouraged to develop textbook selection policies.

It is not surprising to find that some students found difficulties in reading the school science textbook studied. All educational activities should challenge students, that is the nature of education. Neither is it surprising that the recommendations put forward to help bilingual students tackle school science textbooks would be of benefit to all textbook users. Like most research, this work has exposed general truths by concentrating on the particular. However, the fact that these recommendations could be of benefit to all, and should thus be easy to implement, endorses their importance. The difference between the bright figures advocated by African publishers reported in Chapter 2 (see 2.4.2) and the improvement of clarity and coherence in writing and the provision of differentiated material, put forward in these conclusions is the difference between *exclusiveness* and *inclusiveness*. It is the difference between separate materials for monolingual and bilingual students and the same materials for monolingual and bilingual students. Its inclusiveness makes it a possible course of action.

In the author's opinion, differentiation and multimedia textbook presentation, are key areas for textbook development in the next decade. If producing a differentiated textbook is difficult and if they are being superseded by CD-ROMs, one inevitably asks the question "*Are textbooks really necessary?*". In their defence, one can say that textbooks provide, cheap, colourful, portable materials and that the different styles and approaches provide a great deal of variety and choice for classroom materials. They can still be reproduced to better quality than teachers' own materials and save teachers valuable time.

Electronic media provide tremendous potential for differentiation within material, through feedback loops and graded tracks and networks through material. Unfortunately, this potential has yet to be fully exploited by publishers and planners. Eventually, when every student has a portable computer, electronic media may provide the ultimate in differentiated materials which would prove a boon to all students and especially to bilingual students. In the meantime, some of the language used on CD-ROMs for schools is, in the author's view, entirely inappropriate. As yet there is not the variety of materials found within the range of textbooks in CD-ROM resources. The author predicts that *there is life in textbooks yet!*

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Appendices

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Appendix A: Profiles of the schools involved in the study

Contents

Appendix A

Explanatory Notes

This Appendix contains profiles of all the schools involved in the project which in some cases include information about the wider linguistic environment. It also contains copies of the interview schedules used in the structured preliminary interviews with Heads of Science and examples of some of the correspondence with schools. The preliminary interviews were carried out during the first visit to each school and were recorded on audio tape. These tapes were kept and were available for further reference during the lifetime of the project. Useful documents such as school prospectuses and copies of policy statements were also collected during these visits and were kept on file for the duration of the project. After writing up, which took place as soon as possible after the preliminary interview, the profiles were sent to the Head of Science concerned for comments and correction of errors. Any matters not clear from the tape were also raised at this stage. An example of the covering letter used is included in this Appendix. The profiles were further updated and expanded at intervals during the project. These conversations were also recorded on audio tape and kept for reference. Any major revisions to a profile were approved by the Head of Science of the school concerned. An example of an appropriate covering letter used in this process is also included in this Appendix. A final format for the profiles emerged during the second round of preliminary interviews during the Spring of 1994. The profiles written during the previous Summer for the pilot study were extensively reviewed and rewritten at this stage of the project.

Appendix A

Policy and Resources Checklist

School .... Date ....

Staff and departmental handbook ....

Language policy ....

....

Class size policy ....

....

Teaching policy ....

....

Special needs policy ....

....

Specialist teaching ....

Strategy for introducing text ....

....

Streaming/setting policy ....

....

Resources ....

....

Language resources ....

Student background and culture ....

....

% Students taking free school meals ....

Language mix ....

Motivation ....

Prospects ....

Other general comments ....

G.M.S? ....

Appendix A

Teaching and Resources Checklist

School .... Date ....

Teacher .... Class ....

Classroom used .... Size of group ....

Setting/ability ....

Motivation ....

Language mix ....

Special needs support ....

Classroom layout ... .

....

Student use of the scientific discourse and the science register...

....

....

Language/text resources ... .

Other resources ... .

Teaching style ....

Learning style ... .

Use of Text ....

....

Teacher expectations ....

....

Student expectations .. ..

....

Other observations ....

....

....

....

Appendix A

49, Drayton Road
Newton Longville
MILTON KEYNES
MK17 0BH

Tel 0908 373263

25th of Mar 1994

Mr. W. H. Beckett
Head of Science
Church of England High School
Any Lane
Anytown
Lancs
XX1 XX2

Dear Mr. Beckett,

Many thanks for giving me your time on Monday. I found my visit interesting and informative and I look forward to working with the department on my research. I thought the students acquitted themselves well and were a credit to both the department and the school.

I have enclosed a copy of the profile of your department which I wrote up from my notes from Monday. Please could you read through and mark any factual inaccuracies. Would you also mark any statements which you're not happy about so that I can delete them. As I explained the document is not intended for wide circulation and, as you can see, the school is totally anonymous. When you're happy with it please return it to me in the envelope provided.

I note that parts of the prospectus describe the School as "(Special Agreement)" and others as "Voluntary Aided", could you clarify this question for me.

I would also like to confirm the date and time of my visit. I'm coming on Tuesday May 17th for lessons with 10 Set 4 which is Mrs. Jones class at 10.05 and 10 Set 2 which is Mrs. Harrison's class. Please could you send me set lists for these two classes. Please could you also remind Mrs. Jones and Mrs. Harrison to fill in the Teachers' Questionnaire for me.

Best Wishes,

JOHN KEARSEY

Appendix A

49, Drayton Road
Newton Longville
MILTON KEYNES
MK17 0BH

Tel 0908 373263

23rd of Apr 1994

Mr. M Weaver
Head of Biology
Independent School
North Road
Anytown
NO6 4AY

Dear Martin,

The main purpose of this letter is to confirm that I shall be visiting your school to carry out research on Wednesday the 29th of June, Friday the 1st of July, and Wednesday the 6th of July 1994. I have enclosed enough copies of the Teachers' Questionnaire for each class studied. However, if a teacher is running more than one class in parallel there is no need to fill in more than one sheet. It would be helpful if they could indicate the classes involved in the space provided. I only need these sheets completed by the Biology teachers of the classes concerned. Teachers need these for the four weeks leading up to the research days.

I have also enclosed a copy of the latest version of the school profile of your school. Please could you look through it and return it to me in the envelope enclosed with any comments and amendments.

Best Wishes,

JOHN KEARSEY

Appendix A

School Number 1004 (Main study)

This is a British international school serving the expatriate British community and other foreign nationals resident in Belgium.

Belgium is an interesting linguistic environment (compare with School Number 1019). The citizens of Belgium speak either Walloon, a form of French, or Flemish, a Netherlands dialect. There is a "*dialectic continuum*" linking all the dialects of the languages known as German, Dutch and Flemish [Crystal 1987 p. 25]. A linguistic boundary runs across Belgium [Muller 1992 p. 71]. The Flemings who live in the North and West descended from the Franks. They speak dialects of Dutch known as Flemish or Vlaams. The Walloons who live in the South and East speak dialects of French. There is also a small German speaking area in the East. Brussels is officially bilingual though predominantly French. Early Belgian history saw French as the dominant language but official status was given to Flemish in 1930 [Crystal 1987 p. 37].

Flemish is an imprecise term describing a language spoken for the past 1,000 years North of a linguistic boundary running from Aachen to North of Lille [Muller 1992 p. 71]. It is a mixture of Flemish dialects and Standard Dutch. *Walloon*, on the other hand, is none other than French with a number of Walloon idiosyncrasies. Flemish has never really developed an independent written language of its own, instead it uses Standard Dutch enriched with a number of Belgian characters. This form is the spoken language used by the media, Church and schools.

Linguistic issues have dominated Belgian politics since the granting of official status to Flemish in 1930. Efforts were made to establish language frontiers and to provide satisfactory political representation and educational resources. In 1968 serious rioting over plans to expand the French speaking section of the University of Louvain brought down the Government. The four linguistic areas are now officially recognised but complex social situations are not resolved and several further Governments have fallen over linguistic issues [Crystal 1987 p. 37]. Since 1966 the Government principle has been one of strict monolinguality in predetermined regions (Brussels, which is bilingual, and a small number of linguistic enclaves enjoy special status). It is fair to say that the Flemings tend to speak better French than the Walloons speak Flemish although the languages enjoy equal status. It is also clear that English is making rapid progress as a language of wider communication [Muller 1992 p. 72].

The most recent figures on the sizes of these linguistic groups date back to the Language Census of 1947. The Flemish speakers are losing ground to the French speakers.

Traditionally Flemish speaking areas, such as the scientific zone of the city of Brussels, have seen an influx of French speaking workers and residents.

Casual observers may sense the deep feelings underlying the use of the two languages. The repeated linguistic conflicts are bound up with the history of the region [Muller 1992 pp. 70-72]. I mention just a few examples. I noted a conversation with the air hostess on the journey to Belgium. She said that it is British Airways policy to give out the safety instructions on flights into Brussels in Flemish first then French. If they do it in the wrong order British Airways is likely to get letters of complaint. The University of Louvain (Leuven) was divided into a Flemish University and a French speaking University. The books in the library were divided up as if it were an acrimonious divorce with the even catalogue numbers going to one University, odd numbers to the other. Parallel representation at all levels makes government very expensive.

The linguistic divide is also illustrated by the elections for the European Parliament (1994). Belgians will elect 25 members of the European Parliament in three large constituencies by a process of proportional representation. The constituencies are language based and Brussels voters can choose to vote in either the Flemish constituency or the French one. Fourteen MEPs will be chosen by voters in Flanders, Walloonia will choose ten and the German speaking voters in the East will choose the other one. There are about 3.7 million Flemish voters, 2.3 million franchophone voters and about 60,000 German speaking voters. Half a million Belgian residents from other EU countries could have claimed the right to vote but only 25,000 registered. The largest group of these are Italians.

Until recently road signs were written in the language of a region. So you could be driving to say, Malines and suddenly it disappeared from signs and Mechelen appeared. New road signs are going to be written in the language of an area first and in the other language second, in a different type and in brackets. This will make it easier to find your way around the country. The names of some towns, e.g. Gand (Gent) and Anvers (Antwerpen) are very different in French and Flemish.

During the period of the research work in Belgium (May 26th 1994- June 2nd 1994) various documents were collected for use in compiling this profile and as evidence to support the observations made here and elsewhere in the thesis. All this material was filed for the duration of the project for reference purposes. The material fell into three main categories. First there was relevant material produced and distributed outside the school. Secondly, there was material which the school produced for external consumption and wide distribution and thirdly, there was material produced by the school which was mainly intended for internal consumption and limited distribution.

A small selection of leaflets etc. was collected from a supermarket as evidence of the kind of bilingual environment that these students are familiar with. An issue of an English language magazine published in Belgium called *The Bulletin* [May 19, 1994] includes a *1994 Schools Guide* and advertisements for this school and most of the other international schools in the locality. This gives a useful review of the schools competing with the school in question and a clear picture of the image which each projects of itself. Leaflets about specific courses and school sections were also collected.

Appendix A

The Summer Term Programme for the school's Arts Centre and leaflets about community activities and adult studies illustrate the school's wider role within the life and culture of the expatriate community. Copies of the school's termly newspaper (Summer 1994) and its Annual Review (Summer 1993) include various articles about school and community activities which provide a broad picture of the life and culture of the school. *Creating Excellence* is a 201 page history of the school which was published in 1991 to mark the 21st anniversary of its foundation.

The Principal's Report for 1992/93 is a useful document which provides, brief curriculum notes, a full breakdown of the examination results for 1993 and a summary of resources planning and development. The School Prospectus is another useful source of information about the school. The Teaching Staff Handbook contains useful information about day to day school matters and organisation of resources. This document also includes policy statements/information on Personal and Social Education, Student Counselling, A Students Code of Conduct, Homework, Community Service, Assemblies and Supplementary Studies etc. The Years 10 and 11 Course Guide is a document for students and parents which explains courses, options and other matters such as the *Journal de Classe* and PSE programme. The Key Stage Three and Sixth Form Course Guides are similar but were not collected.

Papers about the management of the Science Department, a breakdown of Science GCSE results for 1988-93, identification of and arrangements for LSD and EFL students, the mother tongues of all the students in Year 10 and Nuffield Co-ordinated Sciences course and revision notes were also filed. Various curriculum documents were collected, the Health Education Syllabus, the Whole School Spelling Policy for Key Stage Three and samples of schemes of work for use with the Nuffield Co-ordinated Sciences Biology material.

This school was opened in 1970 with the support of several multinational companies and the Donation Royale, a trust which administers large areas of royal land in Belgium. It is an independent, coeducational, four form entry community school catering for the full age range from 3 to 18 on a single site. It is situated on the edge of a royal forest. It has extensive playing fields and other facilities including a theatre which seats 240. Students are fee paying but the school does offer a limited number of assisted places. Admission is through an interview procedure. The school caters for a wide range of abilities. Following a recent reorganisation (1993/94) the Senior School caters for National Curriculum Years 7 to 13. It previously dealt with Years 8 to 13 but Upper School staff in various subjects, including Science, also taught in Year 7 which was then included in the Middle School. The School Development Plan includes the provision of new laboratories. The school is not a religious foundation and is not subject to the directives on religion in British legislation. There are no collective acts of worship but there is a World Faiths course in Year 7. There is a Church of England church in the locality. Secular assemblies are held regularly. Over the years there has been a pattern of slightly more boys than girls in the school. In 1991 this was 576 boys (54%) to 493 girls (46%). English is the language of instruction throughout the school.

Appendix A

The school takes pride in its liberal child-centred approach and friendly atmosphere. One noticeable outcome of this approach is the quality of the collaborative learning that takes place in many classrooms. There is no school uniform and students address teachers by their first names. The school strives for academic excellence and enjoys a high academic reputation. There is a varied programme of extra curricular activities and parental involvement is active and encouraged. There are approximately 1010 students on roll, of whom approximately 65% come from a UK background. However, over 60 other nationalities are represented in the student body. (This diversity is reflected in a document listing the mother tongues of the students involved in the research project, Year 10 1993/94, which is on file). It is school policy to celebrate the multi-faith, multi-cultural background of the students. The student: teacher ratio is approximately 11:1.

Students' parents work for embassies, trade missions, multinational companies and EU related enterprises and many come from former British colonies, Africa, the Caribbean, and Europe. Some students have multi-European backgrounds. Some parents are bilingual and use various languages in the workplace but generally English predominates. Most speak good English. They are typically middle managers and professional people. They are very supportive of the school and they look to the community side of the school to provide the British culture lost by being overseas. Families have access to British television and English language programmes are broadcast on the local channels. British magazines and newspapers are also available.

The school is a focus for community cultural activities, not all of them specifically British. Life is very much like life in Britain in the sixties and the community is very conservative. Most families are well off or extremely well off. The exception might be some of the embassy families. Some Governments provide good education for staff families but don't pay their staff particularly well. The students are very well motivated, have a good attitude and generally biddable. Most students have good relationships with their teachers. Many of the students are under a lot of pressure to succeed and work extremely hard.

Some parents choose a British education for their children because they know they will find a British School wherever they are posted. Others choose it because they expect their children to go back into the British System when they return to the UK after a short contract. There is a regular turnover in students due to the shifting work patterns of parents and each year only a handful leave Year 13 who started at Year 1. Turnover could be as high as thirty percent each year in the Junior School. In the Senior School, although turnover maybe as high as twenty percent at the end of Years 9 and 11, it is very low during examination courses. The recession, an increase in competition at the Junior School level and changes in the importance of Brussels as a centre for multinationals, has seen a gradual fall in student numbers. They have dropped from a peak in the mid seventies at just over 1200 to a projected 980 in 1994/95. Year 11 in 1989 was the last of the five form entry years.

The school is a day school and operates a school bus service for many students.

However, a *Host Family Scheme* operates for a handful of students. This is for students whose families are relocated at short notice and provides five-day or full boarding for some students who live too far away to travel to school daily from home. The school has active Arts and Sports Centres which serve as community facilities for not only the British and international communities, but also the local Belgian population as well. The school offers a comprehensive programme of Adult and Continuing Education. The Parents Association offers support to families newly arrived in Belgium. Sixth form students are involved in various community projects such as helping at the local blind institute and old people's home. Links with other local schools have also increased in recent years. The school does not provide school meals, students bring sandwiches or eat takeaway foods as arranged by the parents.

The school is registered as a non-profitmaking organisation under Belgian law. The Board of Trustees consists of representatives of both the Belgian and the British communities. Day to day management is delegated to a Board of Management, the Principal and her five Assistant Principals. The school is organised on British lines and follows courses which provide coverage of the National Curriculum and lead to examinations at GCSE and A Level or GNVQ. Catering for all ages from 3-18 provides the opportunity to treat the curriculum as a whole and to plan accordingly. Students are placed in Year groups based on their age on the 1st of September as in the UK. The school has been regularly inspected by teams of retired and serving HMIs brought in from the UK.

Students learn French throughout the school although the school is situated within a Flemish speaking commune (Teaching one of the indigenous languages from five is a requirement of the Belgian Government. A commune is a local government district.). It is difficult to organise modern language tuition in the school because in every year group proficiency varies from beginners to those who are truly bilingual in French. For some students who are truly bilingual, GCSE French is almost irrelevant. The Modern Languages results at GCSE are very good but there is a fear that the British examining system does not stretch some of the students enough. These students go much further than GCSE, passing the exam *en passant*. Language tuition is given the high priority found in mainland Europe rather than the low priority found in Britain [Evans 1994 p. 12].

Some students have relatively little exposure to French because they live in Flemish speaking communes or are surrounded by English speakers within expatriate areas. Also many Belgians speak very good English and students may not need to use their French much at all. However, the students' awareness of other languages and bilingualism are heightened by the environment and from Year 7 they also study German which is then offered as an option in Year 10. Dutch and Spanish are also offered within the options scheme. EFL is taught to some students in place of German. Many students are bilingual in English and their own language and have been brought up within a multinational environment having lived in various countries. The school does not offer English for Overseas Students (see School Number 1019). Those students who need this qualification gain it through private tuition.

Students are expected to be computer literate by the time they reach secondary level through an extensive IT programme. This enables them to use the computer as a tool in individual subjects in the Senior School. Full advantage is taken of the school's position in the centre of Europe and where appropriate the curriculum is suitably *Europeanised.*

75 students left Year 11 in 1993. They were entered for 616 GCSE examinations. 85% of the passes were at grades A-C, with 29% of the passes at grade A. This is typical of the pattern over the last five years. The results in the three separate sciences, which were option subjects during this period, broadly reflect these figures (see separate analysis on file). In 1993, 93% of A Level passes were at grades A-E with 32% at grade A. In 1992/93, 27% of the secondary age students were in Years 12 and 13 and the staying on rate from Year 11 was 90%. Of the students who left the school in 1993 over 85% proceeded to Higher or Further Education. Most students continue their education at British Universities. The opportunities for entering employment in Belgium are slight and for entering further education in Belgium limited by the standard of written French or Flemish required.

There is a Learning Support Department which provides English as a Second Language tuition and supports students with specific learning difficulties. In the Year 10 group studied (1993/94) there are five students (6.5% of the year group) listed as in need of LSD/EFL tuition. This is typical of the school as a whole (see the document *LSD EFL Arrangements* on file). These students may have specific learning difficulties such as dyslexia. This department works on referrals from initial interviews and through teaching staff concerns. They assess individual needs and help some students by withdrawal. There is some classroom support from Learning Support teachers available in Years 10 and 11.

A Science Department Handbook will probably be produced in the future (1993/94) once the restructuring of the Department settles down and responsibilities are worked out in practice. There are individual discipline statements and reviews. The Department has made an input into the policies set out in the Staff Handbook, a copy of which is on file.

The Principal hopes to encourage educational research and teacher training at the school. The management hope that the school will become an official partner in the Government's scheme for school based initial teacher training. It took three students from Chester College of Higher Education in 1992/93. The Head of Science has been encouraged to take part in training and research as part of the CASE project.

The Department adopted the Nuffield Co-ordinated Sciences course in 1992 in order to retain the character of the separate Sciences within a programme of broad balanced Science which delivers the National Curriculum for Science. Co-ordinated Sciences is a Dual Award core subject studied by all students at Key Stage Four. It replaced a programme of separate science courses in Biology, Chemistry and Physics which students chose within an options scheme. Students could chose to follow just a single science course. The courses offered were MEG standard Physics and Biology and MEG Salters Chemistry and, prior to that, MEG Nuffield Chemistry. The change ensures 20% Science for all students at Key Stage Four. There are no plans to offer Single or Triple Award Science at present. In 1993/94 responsibilities within the Department were adjusted to include roles related to Key Stages to reflect this shift in emphasis (see the document *Management of Sciences* on file).

Science is taught in double lessons of 75 minutes each. Two double periods each week are allocated to Science in Year 7 and three in Years 8 & 9. Four double periods each week are allocated to Science at Key Stage Four. This amounts to 20% of the curriculum time available. The allocation of eight periods a week with five sets in a year group requires careful organisation. Science classes study the separate disciplines in blocks of nine or ten weeks. At any one time they study two disciplines, each for two double periods a week. Then they change teachers and disciplines so that overall they study each discipline for equal amounts of time.

At Key Stage Three students follow a *home grown* modular combined science course in Years 7 and 8 followed by home grown courses in the separate sciences in Year 9 as an introduction to Key Stage Four. The Department is hoping to use the CASE materials with all Key Stage Three students from 1994/95 onwards. These classes are taught as mixed ability Tutor Groups consisting of a maximum of about twenty students.

Key Stage Four groups are mixed ability sets, of up to 17 students, setted on the basis of social groupings. Students requiring Learning Support tend to be grouped in one or two classes to maximise the value of the Learning Support available to the Department. In the Year Group studied for the research these groupings were affected by groupings for Design and Technology. By grouping Technology students together for Science the possibility of integrating assessment in IT in Technology and Science was left open. Students sit the SATs but these are not reported or used for setting purposes.

All members of the Department teach within their discipline from Year 9 onwards except for two teachers who teach outside their discipline in Key Stage Four for timetabling reasons rather than personal preference (1993/94). These teachers have stuck to the topics closest to their specialisms and have been supported by specialist colleagues. There are some members of the Department who do not teach classes below Year 9 (1993/94). However, it is Departmental policy that all are expected to teach the full age range (11-18 years). The Department consists of the equivalent of 7.25 full time staff. The Department is made up of competent, well established, mature teachers. Teaching styles and approaches are left to the individual teacher to decide what is most appropriate delivery for a particular group of students learning a particular body of subject matter. This extends to strategies for introducing text. There is a variety of approaches. Departmental staff meet regularly both formally and informally and there are exchanges of ideas and discussions of appropriate approaches. However, the use of the course is quite prescriptive of teaching style and approach. There is a preference for writing up work in an impersonal scientific style. This is expressed by example rather than policy. Teachers within the Department also teach the scientific way of drawing diagrams.

All science lessons are taught in nine purpose built laboratories. Most have fixed benches. These laboratories are due to be replaced in the next few years (1993/94). The rooms are long and thin and vary in floor area between 54 and 60 m^2. The shape of the rooms combines with cumbersome furniture to make them quite cramped even with a maximum class size of 20. The Department is well resourced and Key Stage Four students benefit from the availability of the equipment provided for a large sixth form. The Department have access to computers in every laboratory. There is a large, well appointed, greenhouse adjacent to one of the Biology laboratories. The Department have access to a CD ROM at present (1993/94) with a view to evaluating its usefulness. There are sets of various standard textbooks available within the Department. Each Key Stage Four student is issued with copies of all four Nuffield Co-ordinated Sciences textbooks together with various other textbooks for Physics and Chemistry. The Department also use a lot of photocopied material in Years 7 & 8 alongside Starting Science 1,2 & 3. The Biology Department use the Nuffield Co-ordinated Sciences Biology textbook as their sole printed resource for Key Stage Four. The Biology Department also make extensive use of video material.

School Number 1007 (Pilot study and Main study)

This is a four form entry, coeducational, selective 12-18 county grammar school in a town in Buckinghamshire. Admission to the school is through the 12 Plus examination. There is also a steady stream of prospective students wishing to enter at all Years. These are subjected to rigorous interview. The entry procedure, which is the county policy, is set out in the school prospectus which is on file. Although the school is situated within a mixed community including Asian families, it has surprisingly few bilingual students. There no are obvious reasons for this. Other schools in the town, such as the Upper School, have a higher proportion of bilingual students.

A very large proportion of students stay on into the sixth form (about 90%) which also takes in large numbers of students from other local schools. In a typical sixth form year group maybe 120-130 stay on and 70-80 come in from other schools. The year groups in the sixth form are thus bigger than other year groups. The sixth form of 380 is almost as big as the rest of the school. Most students go on to higher education from the sixth form.

The vast majority of students' parents are very supportive of the school and their children. The students' backgrounds could be described as *middle of the road* with a few students from poorer homes. The students mix together socially very well and work together well. They are pleasant and well motivated. However, motivation and enthusiasm tend to wane a little in the sixth form. Standards of attendance and behaviour are very high. The management of the school are proud of their League Table position. The school competes with two other local grammar schools. Over 95% of the students gain 5 or more GCSE passes at grade C or above. In 1993 93.6% of GCSE candidates gained grades A-C in Nuffield Co-ordinated Sciences. Other examination result information is set out in the school prospectus. Less than 10% of the students are entitled to free school meals. Grant Maintained Status has been discussed within the school and governing body but has been resisted. The atmosphere is generally academic but informal.

There is a Biology Department policy statement on various matters (I have copies of various relevant sections on file). There are also school policies on language across the curriculum policy, gender, equal opportunities and race which could be made available. Although the number of students with learning difficulties is not large it has become more noticeable during the last four or five years. These students are helped through withdrawal from lessons. This is *fairly rare* and *not liked* by the students concerned. There is no specific help for gifted students but some of the brightest children are offered extra tuition on an informal basis.

The Science Department is quite well resourced. About 85% of the science teaching occurs in laboratories. The accommodation is varied in terms of available space. There is enough equipment for students to work in pairs on Science 1 investigations. Students have some access to computers, a CD- ROM and data logging equipment. All the equipment is interfaced for use with computers. There is an RML network but it's quite old and the software is out of date. There is access to a room with ten stand-alone IBM computers near the laboratories. There are three CD-ROMs available for student use on the whole school site. Every student is issued with a copy of each of the three Nuffield Co-ordinated Sciences textbooks. The Department have an excess of textbooks.

Class sizes for Nuffield Co-ordinated Sciences vary between 20 and 28, however, in the Lower school there are classes of over thirty. All students take Nuffield Co-ordinated Sciences at Key Stage Four. There has been some pressure to offer Single Award Science which the Science Department has resisted. They are seriously considering offering Triple Award Science for some students but they are loathe to burden staff with more changes to the curriculum at this time (1992/3).

There is no particular teaching policy within the Science Department, many styles and lesson formats have been tried including role play which has been particularly successful. Some members of the Science Department teach their students to write up experiments in a very formal, scientific way but there is no departmental policy on this. It is departmental policy that teachers should teach within their own discipline wherever possible. Some members of the Science Department are not prepared to teach outside their own discipline. There is a slight shortage of Biology teaching in the Science Department. Biology teaching is made up of 2.7 full time equivalents at the moment.

The school adopted Nuffield Co-ordinated Sciences in 1988. It replaced courses in the separate sciences, including Salters' Chemistry which was very successful, and NEA Modular Science. The change was in response to the call for broad balanced science. The Science Department like Nuffield Co-ordinated Sciences and think that it works well with their students. It is academic and is a suitable preparation for A Level Sciences. However, some members of the Department are critical of the exam (1994). The biologists complain that there is too much emphasis on data handling. The Department now wish that they had retained separate sciences for some students, perhaps for two out of six groups (1993). The Department will offer Triple Award Science from 1994/5, initially to one group of students. These students will be provided with appropriate new texts. This may involve different courses in the different science disciplines. There are clear distinctions between the separate science disciplines within the Department. They will stick with the Nuffield Co-ordinated for the time being for Double Award candidates, but have declared a moratorium on buying any more of the Nuffield texts.

The separate sciences are still taught in Years 8 and 9, within a co-ordinated course based on Active Science. This course uses some of the Year 8 and 9 Nuffield material. Key Stage four students are allocated eight thirty five minute periods of science a week which constitutes 20% of their curriculum time. Biology is allocated an equal amount of this curriculum time with Physics and Chemistry. This equality is achieved by a *roundabout* system of organisation where the subjects take it in turns to have only 2 periods a week with each class in turn. This change around occurs every six months or so and involves a change in teachers for some classes.

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The whole year group is taught at the same time. There is no setting in Years 8 and 9. In Year 10 there are six groups setted straight through on the basis of ability in Science as tested in end of year examinations in Year 9. The groups are carefully balanced in terms of gender. The two classes taking part in the pilot study are judged to be in the middle range of science ability for this school. Out of six groups, 4E is the second one up from the bottom, 4B is the second one down from the top.

The Head of Science in this School is a user group organiser for Nuffield Co-ordinated Sciences. There is an article taken from Education in Science [Bainbridge 1994] written by the Head of Chemistry of this school on file.

Appendix A

School Number 1009 (Main study)

This is a large Local Authority, coeducational, partly residential, special school, catering for the visually and physically impaired and situated in the Midlands. It has provision for up to 250 students of all abilities between the ages of 2 and 19 and has specialist medical facilities on site. The School Aims Statement which "*underpins all our activities*" is summarised in the school prospectus and expanded in an 1994 Open Day document. Copies of both of these documents are on file. This prospectus emphasises the importance of the partnership between home and school and outlines the facilities available. The site also accommodates The National Association for Special Needs Education, The RNIB Care Training Service and the local Health Centre. The school is adjacent to an LEA Combined school. The school has not yet become grant maintained but this is an option under consideration (1993/94). The school has a lot of visitors and students are used to the presence of strangers in the classroom. Several members of staff have come from mainstream schools.

Some of the students have learning difficulties as well as physical handicaps. Some have a history of school refusal. The school has always had a national role and approximately 100 of the students are resident. However, many of the students come from the local LEA. All students have meals provided by the school (until Summer 1994). The school provides access to professional care and specialist resources to meet individual needs. It provides mobility and independence programmes, helping the students to learn how to cope with life beyond school and maintains links with mainstream schools. All these facilities are described in the prospectus. The school provides for delicate students who need the availability of the medical facilities, such as asthmatics. It also caters for students who have missed large chunks of schooling for a variety of reasons including medical problems. Generally the students are interested in Science and are keen to get involved with practical work. There are some bilingual students reflecting the school's national catchment. However, English is the language of instruction and is the only language spoken in the classroom.

The current student body reflects modern Government policies regarding the integration of students with disabilities into mainstream schools wherever possible (for example see the profile on School Number 1031). Those most able to cope tend to be brighter students. Staff are generally optimistic about students' future prospects as members of society (1993/94). They recounted pleasing improvements in individual student performances. Some students leave the school at 19 for higher education and University. Last year (1992/93), all Year 11 students were entered for GCSE Science. However, staff are less optimistic about students' employment prospects on leaving school in the present climate and with the Government's reluctance to enforce disabled persons quotas (1993/94).

The prospectus includes information about examination performance at GCSE and A Level. In the 1991/92 Year 11, the breakdown of GCSE grades is similar to the UK average with 47% of grades at A-C. The A Level results in 1992 were better than the UK average but involved only a small group of students. The prospectus also contains information on students' destinations on leaving the school (1988-1992). Many students leave to continue their studies in Higher Education, Special Further Education and Further Education with a smaller group leaving to join sixth form colleges. Another large group leave for YTS and Employment. Very few students become unemployed on leaving.

There is a departmental handbook containing useful information about safety policies etc. However, it is under review following a local authority inspection (1993/94). The Department have a reflective, pragmatic language policy. They implement *whatever works best* with particular groups of children. The school has a Special Needs policy encapsulated in its Aims Statement which is on file.

The school adopted the Nuffield Co-ordinated Sciences course in 1988. It replaced single subject science courses. This change was in response to the call for broad balanced science whilst still preserving the separate science disciplines. Students use the Nuffield co-ordinated Sciences textbooks in various ways. Most students have physical problems reading the books and some use copies read on to tape and other reading aids. Although the taped versions include the captions to figures they do not include descriptions of diagrams. This can prove confusing and frustrating for students. Conversion of the books to Braille is not really practical, it would make a very big pile of paper. A taped version of the cloze tasks was prepared for those students who want to use them. They can play the tape back over headphones. Stopping, rewinding, and replaying such a tape simulates the reflective process engaged by all readers. The Department have made four copies of the books in large print through photocopying. These have the disadvantage that they present the figures in black and white only. Closed circuit TV is a valuable technology which enlarges any book and preserves the original colours in figures.

Class size varies depending on the disabilities of individual students but generally works out at about seven students to one teacher. Some students have classroom assistants to help them. In the 1993/4 Year 10, there are 22 students in three classes, two taking Double Award Science and one taking Single Award Science. Double Award Science groups are allocated six one hour periods of Science a week. Single Award Science groups are allocated three one hour periods of Science a week. This time is divided equally between the science disciplines. Compared with the rest of the curriculum, this is equivalent to the time allocated to two option subjects and one option subject respectively. It is difficult to compare time allocation with mainstream schools as this curriculum includes additional subjects such as Mobility and Physiotherapy. The amount of setting possible is limited by the options system which is very dependent on the make up of French sets. All three classes are taught in three purpose built laboratories and a classroom/laboratory. All Science is taught in these laboratories which are adjacent to one another and to a central preparation room. The rooms are large with flexible work spaces and bench heights to suit a variety of students including those confined to wheel chairs and those with specific, individual disabilities. Classes are small enough, and rooms large enough, to facilitate a teaching style which allows movement around the room to make use of specific science equipment and the necessary teaching aids during a lesson.

The Department is staffed by four teachers and two technicians. The teaching style is relaxed and informal. Teachers in the Department making conscious efforts to tailor the material presented to individual and group needs taking *the whole child* into account. This informal atmosphere enables students to handle and feel equipment in order to gain a clearer mental picture of what's going on. Teaching policies and styles are left to the individual teacher and are related to the content of the individual science disciplines. Each teacher works in their own way but good practice is shared by all. Apart from their disabilities, the students are normal teenagers and exhibit the usual forms of classroom behaviour and learning problems found in any classroom. There is an emphasis on the separate science disciplines and the individual expertise of specialist teachers within these disciplines. Teachers avoid teaching outside their specialism but *it does happen*. The departmental view is that it is best for teachers to teach to their strengths in a situation where there are so many classroom complications not related to subject content.

Strategies for introducing text vary between teachers and disciplines. However, there is a problem with the high reading level required by the text. Sometimes the text is used just as a prompt, reading material to students can take up a large part of lessons, but some reading might introduce some pieces of work. However, teachers here tend to reduce reading to a minimum to enable students to get on with the practical work. A common approach is a sort of *teacher narrative* style of teaching where teacher talk replaces the written text. In this approach the biology teacher uses the diagrams found in the book more than the text. Speaking to them and describing and explaining them. This can be very effective in these small groups. The Department use just the Nuffield Co-ordinated Sciences books in Years 10 and 11 and also use the Nuffield Key Stage Three material.

The Department possesses a wide range of special resources including talking thermometers, ammeters and wordprocessors. They have a chemical balance which gives an audio output. Partially sighted students use these and meters and thermometers which give clear digital readings. The value of closed circuit TV has already been mentioned. This is a resource which would enhance learning in any classroom. Brailling machines and *touch sensitive* graph paper are also used where appropriate. The Department makes extensive use of video material where this is appropriate. The school has a very good AV Resources Department which the Science Department makes extensive use of. They use audio taped materials a great deal and also have a video microscope.

Appendix A

School Number 1010 (Main study)

This is an eight form entry, 11-18 co-educational, LEA community college in the South West of England. The school has a pleasant, informal, easy going, atmosphere. The admission level for September 1994 has been set at 288. The total school role for this split site school is about 1400 with about 200 students in the sixth form. At one time the total school role reached 1700. There are slightly more girls than boys in the school, a feature which is particularly noticeable in the sixth form [Ofsted 1994e p. 5]. The school acts as a local centre for adult education and youth work. About 40% of the students in each Year 11 group gain grades A-C in five or more GCSE examinations. The pass rate at A Level in Year 13 is also good, generally at about 80%. An analysis of the examinations results for 1993 is set out in the prospectus, a copy of which is on file. The school was founded in 1547 as a grammar school and provides facilities for 70 boarding pupils. However, in 1994 only 24 of these boarding places were taken up [Ofsted 1994e p. 44]. A new principal started at the college in April 1994. The governors and other groups have discussed the possibility of changing the funding of the college to grant maintained status. This has not been pursued any further at present. The school was inspected by Ofsted during the study (during the Autumn term of 1994/5). A copy of the report on this inspection is on file and was used in compiling this profile [Ofsted Report December 1994 under contract no 911\S4\000856]. Two girl students' contribution to the national SET Science event was reported in The Independent [22.03.94]. A Year 9 Chemistry team won the regional final of a Royal Society of Chemistry competition. They proceed to the national finals in October 1994.

This is country school, taking about a quarter of its students from the relatively prosperous town and the others from the surrounding smaller rural communities. The majority of students travel to school by bus. The students have a range of backgrounds, from the children of farm labourers to those of professional people. The main sources of employment in the locality are farming, a variety of light industries and small businesses. Local unemployment is well below county and national averages [Ofsted 1994e p. 5].

Whilst many of the students speak with a West country accent and use dialect words in their speech [Crystal 1987 p. 30], there are also many students who have a sort of *Middle English* accent and do not use dialect words. 5% of the students are entitled to free school meals, half the county average and a third of the national average [Ofsted 1994e p. 5]. There are students who are well motivated but most suffer from a sort of rural inertia. An increasing number of students (about half) stay on in full time education at 16+, joining the sixth form or entering further education elsewhere. The school has responded to this demand by providing a wide range of GNVQ and A Level courses. Of the rest of the students leaving Year 11 very few remain unemployed [see Ofsted 1994e p. 7]. Of the 1993/94 Year 11, 90.0% achieved grades A-G at GCSE with 49.3% gaining grades A-C. The first figure is slightly below the county average, whilst the second figure is slightly above the county average. Both figures are above national averages.

Appendix A

The school is proud of its record of innovation and caring for students. It has two trained counsellors to talk through problems confidentially with students and their parents and policies on bullying and classroom behaviour including appropriate strategies for dealing with these situations such as a remove room.

The school is a base for the county Specific Learning Difficulties Unit. This unit provides specialist teaching for students with statements of specific learning difficulties. In addition to this there is a team of teachers who support students with special educational needs in regular lessons within the college. About 5% of the students have statements of special educational needs. The college also has a policy to provide for the needs of gifted children. In the Science Department any students needing specific help within some Year Groups are placed in the same class which gets support from the Special Needs Department in the form of classroom help from a Special Needs teacher for some or all of their Science lessons. This means that the limited resources available can be used to best effect.

The decision to adopt Nuffield Co-ordinated Sciences in 1988 was driven by the physicists and chemists who were familiar with Nuffield single subject science courses. It was taken in response to the call for broad balanced Science whilst still preserving the separate science disciplines. It is departmental policy to provide discipline specialist teaching to groups of students of average and above average ability. In 1993/94 nobody taught outside their discipline.

The Science Department are committed to Double Award Science for all and have resisted pressure from other departments for the introduction of a Single Award Science course. They would not wish to offer Triple Award Science because they feel that the Double Ward course is adequate preparation for their A Level courses and can see the value to students of a broad education at GCSE level.

20% of the curriculum time available in Key Stage Four is allocated to Double Award Science. The course is taught on a four week rotation of the science disciplines. Students study each discipline for four week blocks in turn for five one hour periods each week. The time available is divided equally between the disciplines. In the 1993/4 Year 10 the eight forms are divided into nine groups of between 25 and 30 students. Five sets of students of average and above average ability follow the Nuffield Co-ordinated Sciences course and are set by ability. The other 4 sets of students follow SEG Modular Science. They are also set by ability. In the 1994/5 Year 10, all 10 groups will follow the Nuffield Co-ordinated Sciences course. The Department will make good use of the tiered nature of the proposed examining system for Nuffield Co-ordinated Sciences. This will enable more scope for moving students between sets during the course.

The Department have developed a *home grown* scheme using on Active Science and Starting Science with students at Key Stage Three. They became dissatisfied with Active Science because of the style of questioning used in the books, which doesn't suit their style of teaching particularly well, and decided to adapt it. They have incorporated some activities and ideas from the Shayer and Adey *Thinking Science* scheme into this programme. They also hope to use some of the CLIS material within this scheme. This course is *constantly evolving*. Years 7 and 8 are taught in mixed ability Tutor Groups of about 32 students. Year Nine are taught in sets which range in size from 22 to 35. The groups of lower ability are the smaller ones. These Year 9 classes are set by ability into three broad bands.

A Science Department Handbook is being compiled (Spring 1994) and will become available. I have copies of the Department's marking policy, their homework policy and their Key Stage Four Record of Achievement, on file. There is a long standing language across the curriculum policy within the school. There is no declared departmental teaching policy but in Years 7 and 8 the detailed schemes of work dictate teaching styles to a certain extent. There is a similar system in Year 9. There is also a scheme of work for Key Stage Four but here teachers are working within their specialism and are more inclined to do their own thing. The guiding principle is to present the students with a range of approaches, in particular active approaches.

The Science Department make very little use of the Nuffield Co-ordinated Sciences textbooks. There is only one class set of the Physics and Biology books available in the Department and no books are issued to the students permanently. The books are used in lessons on a requisition system. In fact, they keep several sets of the Oxford Co-ordinated Science textbook and make more use of it in the classroom than the Nuffield book. These sets of books may be issued on a temporary basis for the four week blocks of work. The Department use the Oxford Co-ordinated Science Earth Sciences book. "*There are considerable shortages of resources in departments, especially in book provision and in IT. There are too few resources to support effective differentiation of learning.*" [Ofsted 1994e pp. 39-40].

The Department have found that the general readability of the Nuffield Co-ordinated Sciences textbooks make them inappropriate for use with their students. The students find the books difficult to read because the text is dense and difficult. The books only really work with the top groups. The teachers found that there was a lot of information missing from these textbooks. The questions in the Biology book elicit answers from a broad range of sources beyond the scope of the book itself, and are not posed in a way which stimulates the students in this school to go and find out for themselves. These textbooks and this type of questioning do not suit the Department's style of teaching. These teachers introduce text in various ways including reading aloud, reading and answering questions and reading and making notes on specific topics.

The biologists in the Science Department criticise the Nuffield Co-ordinated Sciences examination, which emphasises data manipulation, because it differs from the course materials which concentrate on factual material. In their view there are many facts to be learnt in Biology whereas the papers seem to demand very few. The worksheets are difficult to read and contain unsuitable questions. Like the books, this Department don't use them much in their teaching, preferring other material.

Consequently, the Biology Department have created their own course derived from various sources and including various additional topics which they consider relevant to their students. They use the Nuffield Co-ordinated Sciences course for examination and assessment purposes. They have adapted some of the worksheets and have included these versions in the topic packs which they use with students. These unit packs are issued to students at the beginning of each unit of work and then collected in at the end. There is a sample of one of these packs on file.

Most Science classes are taught in purpose built laboratories. It is difficult to make maximum use of laboratories in a split site school and consequently whilst laboratories lie idle at some times, at other times classes have to be taught in classrooms. Of the laboratories, four have fixed benches, the rest have moveable benches with no services in the middle of the rooms. The Department has twelve laboratories in total together with a small IT room. They are hoping for two more laboratories in the future but they are generally well resourced.

Appendix A

School Number 1011 (Main study)

This is a county, eight form entry, co-educational comprehensive secondary school in Yorkshire. If reorganisation proposals are approved by the Secretary of State, it will change from a 12-16 school into an 11-16 school in September 1994 (Approval was given for this change to go ahead in April 1994). This rationalisation of provision is a consequence of a county policy to abolish middle schools aimed at reducing the number of excess school places in line with Government policy. At one time the authority operated various systems of age of transfer in parallel. If the scheme goes ahead the school will admit two new year groups (Years 7 and 8) in September 1994. A £2 million building programme at the school, including four new laboratories, is ready for implementation together with plans for the appointment of about twelve extra staff (Extra staff were appointed during the Summer Term 1994 and the building is promised for occupation by September 1994).

In September 1993 there were 727 students on role. Years 8 and 9 were substantially larger than Years 10 and 11 (200 approx. compared with 160 approx.). This reflects the fact that the school has become popular in recent years and that local parents have exercised their right to choice of school. All children who live in the catchment area, which includes three villages on the edge of a major town, are admitted to the school. In addition, some students from out of catchment are admitted on agreed criteria set out in the prospectus (which is on file). After reorganisation, the school role will be about 1050. At present about 9% of the students are entitled to free school meals. The students are quite well motivated with reasonably supportive parents. There is not the community spirit found in some rural Yorkshire comprehensives. However, the students are generally pleasant and well behaved.

A statistical breakdown of the GCSE examination results for 1992/3, set out in the prospectus, shows that the school's students performed better than the average for schools in it's locality and also better than national averages. About half the students leaving the school at 16 enter further education. They enter the sixth forms of other local schools, in particular one school which also offers Nuffield Co-ordinated Sciences to GCSE. Another large group (about 20-30%) enter employment through YTS schemes and a smaller percentage (less than 10%) enter permanent employment. Unemployment is high in the area which has been seriously affected by recent closures of coal mines and other local industries.

School and departmental policies are in the process of being formalised and some of these might become available in the course of the study to inform this profile. There is no specific language policy in the school or language across the curriculum policy. The few bilingual students in the school are all fluent English speakers. The form of English used throughout the school reflects the Yorkshire dialect and accent [Crystal 1987 p. 30]. Some of the teachers felt that the mismatch between the dialect of the students' everyday discourse and the Standard English of the textbooks and exams may cause students problems and lead to underachievement. The school has a strong, well defined Special Needs Policy.

All Science tuition in Year 8 is in tutorial classes of 25 to 26 students. In Year 9 the students are taught in two half years which are set by ability in Science into two broad ability bands. All students in Years 10 and 11 follow the Nuffield Co-ordinated Sciences course. They are set on ability within two half year blocks on the timetable. In the 1993/4 Year 10 this is a block of three classes and a block of four classes. The composition of the blocks depends on students' ability in Maths, the block of four classes containing both the most able and least able mathematicians. Six periods of 45 or 50 minutes are allocated to Science each week in Years 10 and 11. This amounts to approximately 20% of the total curriculum time available. This time is divided equally between the Science disciplines, with one double period allocated to each discipline each week. Years 8 and 9 are allocated four periods of 45 or 50 minutes each week.

Suffolk Co-ordinated Science was chosen for use in Key Stage Four in 1988. The department like the philosophy and science process approach which was embodied within Suffolk Co-ordinated Science. The course worked well with both students and staff, and examination results were encouraging. The department continued with Suffolk Co-ordinated Science *"for as long as we were allowed"* and then moved to Nuffield Co-ordinated Sciences in 1990. The balance in this decision was swung by the desirability of conforming with the school where the majority of students go for sixth form studies. By the time the school studied had adopted the course other local schools, who had adopted it in 1988, were already dropping it because they were dissatisfied with their examination results. This enabled this school to pick up a lot of second-hand textbooks cheaply. Both of these co-ordinated science courses have allowed the department to deliver broad balanced Science yet they still enabled colleagues to each teach their own subject specialisms. After excellent results with Suffolk Science up to 1993 the school fears that the examination results with Nuffield Co-ordinated Sciences in 1994 may be disappointing. They will consider dropping it when they review the 1994 examination results. The Head of Department has complained to the Nuffield Chelsea Curriculum Trust on this matter.

All members of the department have a second science discipline in which they feel reasonably competent. Most sets are taught by subject specialist teachers for the three science disciplines. However, in the block of four sets the lowest ability class are taught by the same teacher for all their Science lessons. The department can find volunteers to take on this task. This is the department's way of providing for students with special needs. The teacher involved gets to know the students better and the students find themselves in a very supportive environment. The department also benefits from classroom help from the Special Needs department and by the release of members of the department to help colleagues in specific lessons. One way of introducing text used in the Department is go round the class with each student reading short sections of it.

There is room for flexibility within these curriculum arrangements by agreement between individual teachers working with a half year block of students. Such a team of teachers always consists of one subject specialist in each of the science disciplines. All the members of the department teach all three disciplines in a *home grown* combined science scheme used in Years 8 and 9. This scheme will be reviewed if the school reorganisation takes place. The department will then be responsible for the whole of Key Stage Three in Science.

There is regular discussion of teaching approaches within the department. The members of the department have different views on teaching strategies and styles but are agreed that a variety of approaches work. They aim to select those appropriate to particular students and particular content in particular circumstances. In general they favour active practical approaches to learning wherever possible. Members of the department use a variety of strategies to introduce text.

The department is quite well resourced. Year 11 students are each issued with a copy of all the textbooks. There are copies of the texts which Year 10 students can loan for a few days from both the department and the library. But they don't have a copy for their own use at home. The Biology text gets quite a lot of use but Roberts is probably used equally as much. Physics teachers in this school have various reservations about the Physics text. The teacher I spoke to prefers *Physics for You* which is a simpler book with less writing in it.

Most science lessons are taught in large, well equipped laboratories which were purpose built in 1976. The laboratories have moveable benches with fixed pedestals for services. One of the laboratories is L-shaped which can cause problems. This room will be converted for other uses when the new laboratories are built. The net effect of the building programme will be three additional laboratories and the loss of this unsatisfactory teaching space. Other effects will be an extra 1.5 teachers and increased technician time.

The class involved in the preliminary study are used to cloze procedures. Their teacher uses them quite often as a teaching strategy (there are some examples of the worksheets she uses on file). It will be interesting to see if this prior exposure to the technique affects their performance on the research tasks.

In response to the go ahead to the reorganisation scheme members of the department were busy in the Summer Term of 1994 creating schemes of work etc. for the new Year 7 intake.

Appendix A

School Number 1018 (Main study)

This is a local authority eight/nine form entry, 11-16, co-educational, comprehensive school in Leicestershire which has won the Schools Curriculum Award. It is planned (1993/94) to reduce the admission limit from 240 to about 210 in the near future to ease the pressures on accommodation and staffing. There are approximately 1150 students on roll at present of whom 95% are of Indian Asian origin. They are mainly the children of people who came to the UK from East African countries in the late sixties and early seventies. Others have come directly from India. They are a mixture of Hindus and Sikhs. The school qualifies for assistance under Section 11 of the Local Government Act 1966. This includes access to a language development team. 18% of the students are entitled to free school meals. The development of students' language is listed in the aims of the school. The school is unlikely to seek grant maintained status in the near future. The school was inspected by Ofsted at the end of the Autumn Term of 1994 [Ofsted 1995a School Number 924/4244]. A copy of this report was used in the preparation of this profile and is included in the school file together with a report from the Leicester Mercury about it and a students' attitudes survey. The report was available to parents together with covering letters in English and a community language. A copy of a multilingual leaflet, produced by the *family* of schools of which this school is a member, is included in the school file.

The students are well motivated and their parents are generally supportive and ambitious. Many students proceed to higher education and in the present climate of unemployment their prospects on leaving school are reasonably good. At the end of Year 11 over 80% of students transfer to local Sixth Form Colleges or Colleges of Further Education and many later gain places in Higher Education. Of the students leaving for employment at 16, the majority join companies on YTS schemes. All students work with teachers and local industry within the Leicestershire COMPACT scheme which is designed to improve their employment prospects. The school have provided information on the destinations of leavers over the years 1988-1993, which is on file. The percentage joining a sixth form or enrolling in Further Education has gradually increased over this period from 69% in 1988 to 90% in 1993. The full breakdown for 1993 was 90% entering a sixth form or FE, 3.8% joining Youth Training programmes, 2.8% entering employment and 2.4% unknown. This is based on a Year Group of 211 students. The figures also reflect changes in the size of the school. Year 11 consisted of 230 students in 1988, 174 in 1989, 160 in 1990, 176 in 1991, 160 in 1992 and 211 in 1993.

The school serves its local community and entry is open to all students who live within the catchment area. The catchment area comprises a *slice* of the city from the boundary right into the town centre, an area consisting of various estates. The catchment area is thus varied but includes no really affluent parts of the district. Other students are admitted according to agreed criteria set out in the prospectus, a copy of which is filed. The school is involved in a link with a local Special School for those with severe learning difficulties. Students transfer from the Special School on a full or part time basis for the last three years of their school career.

Links with the community include the celebration of the Hindu festival of Maha Shivratri at the school. The school is involved in links with the WWF Vrindavan Forest Revival Project in Vrai India and The Modern School in Mussoorie India. There are also plans for links with the city of Rajkot in Gujarat, India (1993/94). It is possible for students to learn Gujarati, and to learn how to play traditional Indian musical instruments such as the sitar and tabla, at the school. Community links are praised in the Ofsted report [Ofsted 1995a sections 175-179].

There is a school policy statement against racism included in the school multicultural policy documents. This includes policy on language and dialect. The school's racism policy is also set out in the prospectus sent to parents. The school aims to identify a whole school language policy. There is a commitment to promote bilingualism, to use mother-tongue teaching where appropriate, and to value community languages [Ofsted 1995a sections 138-149]. Teachers are encouraged to produce assessment materials in a range of languages. The school file includes some samples of Science materials written in Gujarati which were produced as a result of collaboration between the Science and Special Needs Departments. The school aims for the whole staff of the school to reflect the community which it serves and to provide suitable role models for students. A copy of the Language Development Team Policy Document is included in the school file. This document explains funding (which is secure until April 1994), needs analysis, new admissions and initial English, mainstream support, types of support and referrals.

Some students qualify for classroom support. The support provided varies depending on the circumstances and staff involved. The school is in the process of producing a Special Needs policy (1993/94). In Key Stage Four Science, a group of students with particular language problems is identified who study towards Single Award Science but in the time allocated for Double Award Science. The school file includes a sample of the materials produced for this group. *There are 16 pupils (1.3%) with statements of special educational needs, broadly average for the shire counties. In addition, approximately 20% of the pupils receive some additional learning support and the majority of students at some point in their school career, receive some language support from Section 11 staff* [Ofsted 1995a pp. 3 & sections 138-149].

Four groups of students in Year 10 take Nuffield Co-ordinated Sciences, these tend to be the brightest students (1993/94, 2 groups 1994/95). The rest of the students (six groups) follow the SEG Modular Science course based on Science at Work. Two half years are setted by ability using the end of Key Stage Three SATs, into two groups of five sets which meet at the same time. In the 1993/94 Year 11 all students study Nuffield Co-ordinated Sciences. There is a history of Leicestershire Modular Science and then LEAG Science in the school. The Department changed to Nuffield Co-ordinated Sciences for all students in 1991 as a better preparation for study at A Level. It has high esteem and is attractive to ambitious Asian parents. However, the examination results have been disappointing compared with the achievement of other local schools following courses such as NEAB Modular Science. Hence the decision to enter some groups of average and below average ability for the SEG course which is similar to LEAG. The commitment to Nuffield Co-ordinate Sciences, although it has involved a lot of work, is still under review. The Head of Science reported that "*quite a lot of schools*" in the Authority had dropped the Nuffield Co-ordinated Sciences course following disappointing examination results.

Approximately 20% of the curriculum time available to students in Years 10 and 11 is allocated to Science. Periods are 45, 50 and 55 minutes long at present. Students are allocated five periods of Science a week in Year 11 and six in Year 10. Eventually, students will study Science at Key Stage Four for six 50 minute periods a week.

The teachers in the Department don't use the Nuffield text very much because the students find it difficult to read and understand. The questions are not entirely to the point, the text is *long winded.* The Oxford Co-ordinated Sciences textbook (Beckett & Gallagher) is preferred because it is less wordy and essential information is set out in a more user-friendly way. However, both books lack a glossary which would be particularly useful with the students in this type of school. The Oxford book provides *a map of the terrain* rather than a description of the content. The language of the Nuffield text is criticised as too convoluted and likened to programmed learning and self study texts. The Department had to decide on a Earth Science text to supplement the textbooks to provide full National Curriculum coverage. They bought the Oxford Earth Sciences text, in preference to the Nuffield one. Texts are used mainly in the classroom and not issued to students to take home. The complex wording of the Nuffield texts and worksheets can undermine students' confidence.

The teachers in the Department employ various note taking strategies with students. There is an emphasis on teaching the *language of Science* using various strategies. In the Lower School students are taught a *home grown* modular science course and science class sizes stand at about 28. In the Upper School science classes consist of about 25 students, with the more able groups slightly bigger and less able groups slightly smaller, down to 15 or 16. All teachers teach all the science disciplines in the Lower school and to a certain extent in the Upper school. They are very flexible on this.

The Department have written their own Teachers' Guides for the Nuffield Co-ordinated Sciences course which include vocabulary lists (there are examples of these file). This prescribes approaches to a certain extent. Staff are committed to practical approaches wherever possible. There is formal and informal discussion about the curriculum within the Department which enables the development of new resources. The Co-ordinated Sciences course in Years 10 and 11 was organised into separate weeks of Physics Chemistry and Biology to help with resourcing when all students followed Nuffield Co-ordinated Sciences. With fewer groups taking the course this is now less of a problem.

The Department is quite well resourced. The Nuffield texts are supplemented extensively using other texts and photocopied material. All science lessons are taught in science laboratories, including a free standing county mobile (1993/94).

Most of these laboratories were purpose built and are about twenty years old. The laboratories have island units with moveable tables and fixed benches around the sides. One laboratory was improved during the Summer Term of 1994. The Ofsted report is critical of the management, resources, accommodation, preparation space, storage and organisation of the Department [Ofsted 1995a sections 8, 10, 63-68, 160, 165] and reported some underachievement, "*less sound*" learning and lack of progress in Science [Ofsted 1995a sections 11, 18, 58-62, 122, 124]. They reported a lack of texts in Science [Ofsted 1995a section 160].

This school has a different pattern of term dates and holidays to the other schools in the study. The beginning of May is a particularly convenient time to carry out the research in this school. The school also has a different pattern of school day on Mondays and Tuesdays to the rest of the week. As part of this pattern all the 50 minute lessons meet on Mondays and Tuesdays whereas the lessons which meet on Wednesdays, Thursdays and Fridays are 55 minutes long.

In the 1994/95 Year 10 there are only two Nuffield Co-ordinated Sciences groups. The Department feel that SEG Modular is the appropriate course for a larger proportion of that year group than the 1993/94 Year 10. This decision will take into account the number of students in the year group who have problems with language. There is the added complication that that year group will be divided into twelve sets which will study Science in two blocks of six sets. There are not enough laboratories to accommodate this arrangement and some of this Science will be taught in rooms which are not laboratories. The Department will devise a system to *share the labs around* in these circumstances. The school did not administer the Key Stage Three SATs in Summer 1993/94 and consequently an *in house* test will be developed and administered to inform the setting of the 1994/95 Year 10 in Key Stage Four. They didn't find the SATs were "*very good at sorting the groups out*". The level of discrimination they provide is rather "coarse" (see School Number 1031).

One issue within this school is mother tongue teaching and the translation of texts into community languages. As explained above science materials were available in Gujarati but were not used by students in Nuffield Co-ordinated Sciences classes. Chatterjee discusses the cultivation of science in India [Chatterjee 1993 pp 4-11]. There was little participation by Indians in scientific research in the nineteenth century. However, there was a massive programme of translating the results of modern Science into Indian languages. 776 books on scientific subjects were published in Bengali between 1875 and 1896 and all the major Bengali journals of the time published articles on science. Immediately writers came up against the problem of how to translate scientific terms into Bengali which continues to be difficult. Chatterjee argues that the reason for this is the absence of participation of Indian languages in the formation of modern scientific discourse [Chatterjee 1993 4-5]. From the beginning of the twentieth century when the science departments of Indian Universities began to flourish English has been the professional language of Indian scientists. The function of science writing in the Indian languages has been to make the materials of "*translated science*" available at the lower educational levels and to the general reading public.

"*The engagement with the discursive process of scientific research, which alone can give scientific terminology its consensual fixity, has not been available to any Indian language.*" [Chatterjee 1993 p.5].

Appendix A

School Number 1019 (Main study)

This is a small independent school in Wales serving the English and Welsh speaking communities. The school takes a minority of Chinese speaking students from Hong Kong.

Wales is an interesting linguistic environment (compare with School Number 1004). The status of the Welsh language is an emotive issue in Wales. This is summed up by,

""*Cenedl heb iaith, cenedl heb galon.*"

A nation without a language is a nation without a heart." [Crystal 1987 p. 53].

Welsh and English in Wales [Bellin 1984] is a concise review of the status of Welsh in Wales, including a review of education policy. A survey for the Council for the Welsh Language [Cyngor yr Iaith Gymraeg/Council for the Welsh Language 1978, Harrison et al 1981] reported that 70% of mothers whose children could not speak Welsh nevertheless wanted bilingual secondary education for their them whilst the figure for those with bilingual children was 90% [Bellin 1984 p. 130].

Political, cultural and linguistic nationalism survive in Wales, manifested in Plaid Cymru, the National Eisteddfod and the Welsh language campaigns. There is a separate National Curriculum for Wales administered by the Welsh Office. A Welsh referendum in 1979 voted overwhelmingly against partial devolution from the United Kingdom [Blake 1988 p. 370].

There is a strong literature in Welsh stretching back to the Cynfeirdd, the early poets of the 6th century [Macmillan 1988 p. 1292]. Wales was monoglot until the 16th century, when the Act of Union in 1536 led to a rapid decline in the number of Welsh speakers. Revivals in the 18th and 19th centuries led to the teaching of Welsh in schools. The present century has seen this revival continue on an unprecedented scale, with the language now being given official status. It is too late to say whether this interest has come too late to stem the steady decline in the number of speakers, from just under a million in 1900 to around half a million out of a total population of 2, 790, 000 in the 1981 census. Fresh factors are now operative, including a new Welsh speaking television channel. One effect of the granting of official status to Welsh is that road signs in Wales are now printed in both English and Welsh [Crystal 1987 p. 303].

The school is situated in Dyfed where, in the state primary schools, all instruction is in Welsh for the first two years [see Crystal 1987 p. 303 and Bellin 1984 which includes details of the linguistic status of primary school children in Dyfed 1949-1973 Table 6 p. 132]. In the local secondary school students can opt for instruction in Welsh or English in certain subjects. They are streamed for their knowledge of Welsh on entering the school. Other counties of Wales have different policies regarding the use of the Welsh language in schools [Crystal 1987 p. 366]. There are many schools where Welsh is the language of instruction throughout the curriculum. A limited number of text books have been translated into Welsh (including some of the Nuffield Co-ordinated Sciences material. For examples of science materials published in Welsh and bilingual activities, see Science Catalogue/Catalogue Gwyddoniaeth [Dyfed County Council Education Department 1994]). This work is co-ordinated by the Welsh Office [Vaughan 1992 p. 2]. The WJEC (the Joint Welsh Examinations Consortium) have published a list of the common science terms used in the classroom translated into Welsh.

The most prestigious of the Welsh language science magazines is Y Gwyddonydd (The Scientist) which has been published four times a year since 1963. It is published by the University of Wales. The market has always been very limited and the magazine is sold by subscription only. Cynefin is a magazine dealing with natural history which sells more copies than Y Gwyddonydd. Magazines of this type tend to start up and fold on a short time scale and frequently link themselves to developments on the Welsh TV channel S4C [Vaughan 1992 p. 1]

The Cymdeithas Wyddonol Genedlaethol has published scientific materials in Welsh, for instance conference proceedings containing fairly specific research type articles. They also publish a news sheet called *Yr Atom* which is aimed at completely lay people and which is distributed as a free supplement to the *papurau bro* or community newspapers which are common in Wales [Vaughan 1992 p. 2].

Welsh language materials for teaching Science are in short supply and the Welsh Office funds various groups around the country to produce booklets and packages to meet certain needs. There is an acute shortage of materials for primary schools [Vaughan 1992 p. 2].

Cymdeithas Wyddonol Genedlaethol is also involved in the scientific activities at the National Eisteddfod. The 1992 Science Exhibition contained a mixture of *hands on* experiments, simple competitions and working models. The Society also helped in the preparation of a series of TV programmes produced by the BBC which earned wide acclaim for presenting scientific themes in Welsh. They are hoping to expand this area of activity "*since there is no doubt that S4C now exercises a pivotal influence on Welsh culture*". They have been pressing S4C to devote more resources to Science. The BBC is obliged to supply a certain numbers of hours a week to S4C so the last series was free for S4C [Vaughan 1992 p. 2].

This is a small independent, two form entry 11-18 coeducational comprehensive school situated in the centre of a small town in rural Wales. It caters for a total of 240, day, weekly boarding, and full boarding students. Currently, equal numbers of students fall into each of these three categories. The school was originally founded as a boys' school and has started to admit girls only in recent years. The number of girls in the school is gradually building up. At present the student body comprises roughly two thirds boys and one third girls. The school is one of only four members of the Headmasters' Conference in Wales. From its foundation in 1847, the Sciences were made of equal importance to the Classics in the curriculum provided. The school is a member of the Monmouth Group of independent schools. This group holds regular meetings of subject teachers which acts as a forum for exchanging ideas and discussing the curriculum. Up until this year, 1993/94, 20% of the students in each year group were funded by a Local Education Authority.

The school was founded with the explicit aim of providing students with a knowledge of Welsh, of Science and of the Christian faith. The school prospectus, a copy of which is on file, includes a short history of the school and its founder. Each school day starts with a Church of England act of worship in the chapel which is at the heart of the school. The school enjoys an active artistic and cultural life, owning a *remarkable* collection of paintings and hosting regular recitals, concerts and dramatic productions. The school has a staff/student ratio of about 1:8. Every student is expected to sit at least eight subjects at GCSE. Entry into the sixth form is restricted to those with at least five A-C grade passes at GCSE. About three quarters of the students go on to Higher Education on leaving the school. Of the rest, nearly all leave to employment. Motivation varies considerably amongst the students, as does destination on leaving. This reflects the truly comprehensive nature of the schools' intake.

The school is proud of its academic and sporting achievements and also encourages musical excellence by offering Music scholarships. It is recognised as a *Centre of Rugby Excellence* by the Welsh Rugby Union and has produced 37 full internationals in this sport. It owns about fifty acres of playing fields. An adjacent National Park provides ample opportunities for fieldwork and other outdoor pursuits.

For many years the school has attracted a small number of Hong Kong Chinese students (about 10% of the student body). The school also has Welsh speaking students and staff (The retiring Head of Science is a fluent Welsh speaker, 1993/94). The Head of the Welsh Department said that about a third of the students speak some Welsh on arrival at the school. However, it is only about 10% for whom Welsh is their first language or who *think in Welsh*. In addition, most Year Groups have the odd student bilingual in another language, for example, Spanish. Consequently, the student body includes a sizeable number of bilinguals. The science technician recalled to me A Level Physics practicals involving the Head of Science mentioned above, where it was not uncommon to hear discourses in Welsh, English and Chinese going on at the same time.

The school exists within a bilingual environment, many of the signs etc. around the school and the locality are in both English and Welsh (some sections of the school prospectus are written in Welsh, compare with School Number 1004). However, English is the medium of instruction throughout the school and most discourse within the school is in English. All students are taught some Welsh, either as a first or second language and many take Welsh at GCSE and A Level. Latin, Greek and French courses are also available. The school has a special unit which teaches English as a foreign or second language. It offers the *English Language for Overseas Students* GCSE which is essential for University entrance English for the Chinese students, who also follow courses in conversational English within the

Department. In addition, some of these students sit Chinese at GCSE and A Level. The school enjoys links with France, both through links with a school in Normandy and through the town's twinning arrangement with a town in Brittany.

There is no Science Departmental Handbook at present but policy documents are being formulated (1993/94) and may be made available in due course. There is no formal Special Needs policy but the Science Department has an arrangement with the English as a Foreign Language Department where students who have difficulty with English can be helped with the language aspect of science work within that Department. The EFL Department will support these students by going through relevant sections of the Nuffield texts with them. The school is truly comprehensive in terms of the ability of the students. Consequently, the Department see their setting policy as a way of providing for the special needs of individual students from the Oxbridge entrant to those who struggle to gain a few GCSEs.

The Science Department opted for Nuffield Co-ordinated Sciences in 1988 in order to offer broad balanced Science, yet to still retain the character of the separate science disciplines. It was seen as a course which emphasises the application of Science and its social aspects. They see it as equally attractive to boys and girls and a sound preparation for further studies of the separate sciences at Advanced Level. This policy is set out in the school prospectus. The school and Science Department are committed to delivering the National Curriculum for Science.

The sciences were taught independently in the past but with the advent of the National Curriculum and broad balanced science, the Departments have grown together and are now (1993/94) in the process of developing a coherent approach to Science. They meet regularly and exchange ideas. Science is taught through a combination of approaches, as appropriate to content. The Department teach through practical work wherever it is appropriate and feasible. All three science subjects are very well resourced, some of these resources are enumerated in the school prospectus. On top of this the students look after these facilities well. Science is taught by subject specialists in Years 9, 10 & 11. In Years 7 & 8 one teacher covers all the science disciplines with a class. Each student is issued with a new copy of each of the Nuffield Co-ordinated textbooks at the beginning of Key Stage Four on payment of a *hire charge*. Class sets of Mackean and old Nuffield Co-ordinated Sciences Biology textbooks are also available in the laboratory. All Science is taught in four purpose built laboratories with fixed benches. The building housing the Science Department is in the process of refurbishment (1993/94) starting with the outside.

A topic is probably introduced by the teacher before students use the Nuffield Co-ordinated Sciences Biology text. Then they might read it and ask questions if they don't understand. Difficult points might then be reinforced using an OHP or another teaching aid. Lastly, students may write *dictionary definitions* of particular *key words*. Although students need to learn the language of Science, one of the effects of Science AT1 is a reduction in the amount of formal writing up of practical work. There is more emphasis on investigation and the interpretation and understanding of work. The form of writing up is gradually evolving as the teachers become more familiar with AT1.

The Biology Department is linked with the PE Department in providing Sports Science courses at GCSE and Advanced Level. The development of Sports Science has also enabled the school to adopt a more scientific approach to fitness training and testing with the senior sports teams. This work is shortly (1993/94) to be expanded to include monitoring of the general fitness and health of all the students in the school.

The school day operates in half hour periods. The research cloze task can be administered in double lessons next to lunch time in order to allow enough time for its completion. Six double periods are allocated to Science in Key Stage Four which amounts to 24% of the curriculum time available. All students follow the Nuffield Co-ordinated Sciences course in Key Stage Four and the whole Year group are taught Science at the same times. However, this course is under review and there is a strong possibility that in the future (maybe with Year 10 1995/96) the Department will run separate sciences with their top set, a Dual Award London Science course with the middle set and a Single Award Science course with the bottom set, yet retaining the time allocation. They feel that this is what people want in the market in which they compete. It is the pattern emerging in local comprehensives (1993/94). It is also a pattern which may be more appropriate for the wide range of ability in Science in the school's students.

The students are taught as two mixed ability Tutor Groups in Years 7 & 8. These groups are then setted into three sets set on ability in Science in Years 9, 10 and 11. This setting is based on the results of school examinations held at the end of Year 8. The largest sets in Key Stage Four and Year 9 comprise about seventeen students.

The Department have used the Nuffield Key Stage Three Material in the past but plan to develop their own, *home grown* co-ordinated science course for Years 7 & 8, starting with Year 7 1994/95 and based on the Longman separate Sciences books for Key Stage Three. The Head of Biology was particularly critical of the Biology content of the Nuffield Key Stage Three materials. Key Stage Three groups are allocated three hours of Science each week, making one double period for each science discipline. In Year 9, students will start on their Key Stage Four work based on Dual Award, taught in a flexible way so that it prepares students for the range of options, described above, in Key Stage Four.

The Department finds that the Nuffield worksheets do not match the requirements of Science AT1 very well. They also complained that the Nuffield Co-ordinated Sciences Biology textbook did not contain enough material which was appropriate to the needs of their students. The Head of Biology also reported that at a recent meeting of the Monmouth group the availability of appropriate textbooks had been discussed. Colleagues agreed that textbooks which catered for broad balanced Science are not adequate for current Dual Award and Single Subject Science Syllabi.

School Number 1020 (Pilot study and Main study)

This school is a Local Authority (London Borough) 11 to 18, five/six form entry, co-educational comprehensive which has its own sixth form. It is situated on the outskirts of North London. It is an established school in a large estate. The school population is mixed in terms of culture. 40 languages are spoken. There is a noticeable number of bilingual students, community languages are spoken in the classroom and around the school. The school offers Bengali, Gujarati, Spanish and Turkish at GCSE. There are also teachers from a range of cultural backgrounds. Many of the students come from single parent families and 32% of students are entitled to free school meals. A move towards Grant Maintained Status in 1992/3 was successfully resisted. The school's students have reasonably good prospects of gaining employment or going on to higher education on leaving the school. The recent successes of ex-students in higher education are listed in the prospectus which is on file. Of the 1992/3 Year 11, 69% gained five or more A-G passes at GCSE.

The Learning Support faculty is well established and is in the process (1992/3) of formulating policy documents. There is a six-strong language support team and a learning support team of seven. The Science Department handbook/policy contains various policy documents and was made available (1994). Useful extracts were copied and are on file. This material includes an equal opportunities policy, sample schemes of work and lesson plans for Nuffield Co-ordinated Sciences units and the laboratory rules translated into various community languages.

The Science Department is quite well resourced. It has nine teachers and nine teaching rooms. The department has enough copies of the Nuffield Co-ordinated Sciences textbooks to issue every student with copies of all three and every laboratory has a class set of these textbooks. However, the Physics staff no longer issue their textbook to students (1993/4). Language support is carried out within the classroom rather than by withdrawal. Such language support involves the speaking of minority languages in the classroom. This may mean that all the students in a year group who follow the Nuffield Co-ordinated Sciences course and require support are placed in the same class. This system makes the best use of the support available which is allocated through a system of departmental bids. However, currently (1993/4) the Nuffield Co-ordinated Sciences groups receive no language or learning support. Learning support has been provided for the Single Subject Modular Science course. The Science Department staff had the laboratory safety rules translated into ten community languages to help students but found that this was an expensive exercise in terms of usefulness.

Most Science is taught in well equipped purpose built laboratories (ie over 95%). However, one of the nine science rooms is poorly equipped for practical work. At Key Stage Four, there are about 25 students in each Nuffield Co-ordinated Sciences class, with smaller groups of about 16 following the UCLES Single Modular Science course. A whole year group is taught at a time to enable maximum flexibility in this setting. Several classes in Years 8 and 9 contain more than 30 students.

Students study the separate Sciences in Year 9 and a *home grown* combined science course based on *Science in Process* in Years 7 and 8. Students in the Lower School are taught Science as half years, allowing plenty of scope for setting in Science. There is no particular teaching policy. Most teachers teach within their own discipline, two teach outside their discipline but this is voluntary.

The Nuffield Co-ordinated Sciences groups study all three sciences during each week. Four double periods of 1 hour and 10 mins each is allocated to Science for these groups. This amounts to 20% of the total curriculum time available. Students are taught each discipline for at least one double period each week. In order to allocate the fourth period, groups study each science discipline for two double periods a week on a rota basis so that equal amounts of time are allocated to all three disciplines (1992/3). This system changed in 1993/4 to one involving three separate discipline double lessons and one co-ordinated lesson a week. The whole year group is taught at the same time.

In the 1992/3 Year 10 there are four Nuffield Co-ordinated Sciences groups including one accelerated group and three groups taking single Modular Science GCSE. Selection for groups is on the basis of teacher recommendation and in consultation with the Year Head and the Head of Learning Support. It is considered to be setting on the basis of ability. CS3, the class involved in the pilot study is the accelerated group from the 1992/3 Year 10. They are a very well motivated group of students from a well motivated year group. In the 1993/4 Year 10, 120 students take Double Science, of whom two groups will follow Nuffield Co-ordinated Sciences and the next 3 groups will follow UCLES Double Modular Science. Another 60 Students in three groups follow UCLES Single Modular Science.

The Department adopted Nuffield Co-ordinated Sciences in 1988. It replaced five science courses, Physics, Chemistry, Biology, Environmental Science and Modular Science. The decision to change to Nuffield Co-ordinated Sciences was a hasty one, taken quickly because external money was offered to pay for resources. The Science Department are dissatisfied with the Nuffield Co-ordinated Sciences texts. They feel that the texts are not addressed to their students both in terms of the difficulty of the language and the contexts chosen to explain the material. These comments apply to both bilingual and monolingual students.

Consequently, the Science Department have written a lot of their own material to supplement the course including unit guides for every chapter. They feel that there is too much content. The Head of Science said that in his experience this comment also applied to other schools in the Local Authority using the course. They "*teach from the syllabus rather than the printed resources*" (NB. The printed resources were written before the first version of the National Curriculum so we should expect some redundancy in the materials [Note added 25.06.93]). There is an indication that the students don't use the books much. With the benefit of hindsight the Department would probably have chosen a different course.

The Headteacher of the school asked the science adviser to report on ways of improving the Science examination results after the 1991/2 results were poor. They were not as good as the results from the five separate science courses that Nuffield Co-ordinated Sciences replaced. In particular the adviser commented on the lack of co-ordination between the separate science disciplines and different expectations from different members of staff. The Science Department have addressed this issue by making one of the four lessons a week a *co-ordinated* lesson in 1993/4 Year 10. This is an opportunity to cover integrated topics and investigations. They have written materials, unit guides and unit tests in order to improve the results. They are also trying out the idea of the accelerated group. If the results do not improve within a few years they will drop Co-ordinated Sciences in favour of another course.

The Head of Science has done some writing for journals and books. He expressed a professional interest in the research.

The school are prepared to be involved for the Year 1994/5 in addition to 1992/3 and 1993/4. This would give a total sample of five classes.

Appendix A

School Number 1021 (Pilot study and Main study)

This is well established six form entry, selective independent, 13-18 boy's public school in North London. It has a national reputation. The school was founded in the sixteenth century. This is a Christian foundation following the Church of England tradition. Students attend weekly services in the school chapel. Greek Orthodox and Roman Catholic services are also held each term and a Jewish circle meets each week. The school is a member of the Headmasters' Conference. Within this, they belong to the Eton Group. This is an opportunity for staff to discuss curriculum etc. in a wider forum than their own school. There have been recent changes in Headmaster and Deputy Headmaster (1993/94). There is a short history of the school and its founder in the prospectus, a copy of which is on file. The school has a staff/student ratio of about 1:10.

Although most of the 600 students are day pupils, there are also up to 50 weekly boarders. The number of boarders has steadily declined in recent years. The boys are placed in one of twelve houses on arrival at the school, eleven for day boys and one for weekly boarders. These houses are based on particular areas of North London and are the basis of the pastoral care system of the school. The boys are in the same house as those boys they will see travelling to school, at weekends or who live near them.

About a third of the students are admitted through the school's own preparatory school having taken the school's own examinations. The rest enter via the Common Entrance examination. These examinations are quite rigorous. There are a limited number of Assisted Places pupils in each year group and a few students come from state middle schools etc. A high academic standard is required. The school takes a few students at sixth form level, but they also lose students at this age. It is school policy to restrict entry at ages other than 13 and 16. The admissions policy is set out in the school prospectus.

It is also school policy to develop all the qualities in the students, not just the academic. They have their own residential centre in Wales and they organise their own events such as walking weekends as well as field courses. This policy is set out in the school prospectus which also describes the school's facilities and resources . The school is spread out within a residential area in several separate locations. All students take lunch on the premises.

The school has a good reputation for academic success. About 17-18 students go to Oxford or Cambridge each year. They would expect almost half the students to gain AA in Co-ordinated Sciences and only a very small number get below CC. All students study at least two languages. Nearly all the students go on to higher education. There are a lot of bilingual students in the school, being North London there are Jews, Arabs, Iranians, Greeks etc. However, they are all fluent in English and expect English to be the language of tuition. Coming from North London, the students tend to be well motivated and have parents anxious that they should succeed. There are a few individual motivation/discipline problems. The school is committed to delivering the National Curriculum and the principles of broad balanced Science. The commitment to the National Curriculum has meant an improvement in facilities for teaching Technology.

The staff of the school are conscious of competition from rival schools, the existence of League Tables and the fact that parents tend to compare the fees charged by the different schools. This has meant more pressure from within for academic success.

There are no internal policy documents as such but copies of documents which go out to parents about courses etc. could be made available. I have copies of the school prospectuses for both the Senior and Junior school on file. These outline the school's facilities and philosophy.

The forms are setted on the basis of the boys' ability in English and Science. This does cause problems when a student is very able in English but less capable in science. The six forms are streamed as four bands, the top one, the next two, the next two and the bottom one. From September 1993 this is changing to three bands, a top form, then two equivalent groups and then three equivalent groups. The top form usually consists of about 25 boys. The next two about 23 or 24, similarly with the next two and they try to keep the bottom form a bit smaller at about 20. This gives a year group of about 130. The form studied in the pilot study, 4 BY is one of the two band two classes. It contains "*for one of our forms quite an ability and motivational range*".

All the Science teaching takes place in eleven science teaching rooms which are all laboratories. They vary in size from smaller than usual to about double normal size. There are 12 full time Science teachers, 4 for each discipline. Teaching follows a *question and answer* socratic approach throughout the Biology department. The teachers' expectations of experimental write ups has relaxed in recent years from an insistence on the formal *scientific manner* to a more liberal approach. The laboratories are old fashioned in design but are well equipped, for example, each Biology laboratory has its own video playback facilities and the Biology Department have bought their own video camera. There are also plenty of sets of alternative text books about. Not much use is made of Information Technology in Biology but it does figure in the Physics component of the course. The students have good access to computers in two IT rooms. Each student is issued with a copy of each of the three Co-ordinated Sciences textbooks. The Biology department have started the process of changing over their stock of textbooks to the new edition. In Biology the textbook is supplemented with Mackean's *Life Study* or *GCSE Biology*. There is also an, *in-house* produced, work book in Biology which aids study and provides summaries etc. All teaching, except for very little in Year 9, is done by specialists. The Earth Science aspects of Key Stage 4 are divided between the Physics, Chemistry and Geography departments.

The school adopted Nuffield Co-ordinated Sciences in 1988. Every student takes Nuffield Co-ordinated Sciences to GCSE. In the Third Year (Year 9) the students take an introductory course to bring all students to a common understanding. Then at some stage during the year they begin Co-ordinated Sciences. Six 40 minute periods are allocated to Science, each week, in Year Nine (1993/4). Nine 40 minute periods are allocated to Science, each week in Years 10 and 11, as three singles and three double periods (1993/4). This constitutes a little over 20% of the curriculum time available. Science counts as a core subject within Years 10 and 11 where an options scheme operates.

There are a few students with special needs, particularly dyslexics, who are dealt with outside the school day. Highfliers are dealt with through the system of streaming.

The students in this school are addressed by their surnames.

The Head of Biology in this School is a user group organiser for Nuffield Co-ordinated Sciences.

Appendix A

School Number 1022 (Main study)

This is a Local Authority, girls', four form entry, 11-19 grammar school in South West London. It caters for students of high academic ability and girls, including some who live outside the catchment area, are admitted at 11 as a result of selection tests which are administered by the local authority. These tests examine verbal and non-verbal communication skills. In the case of the odd entry in Years 8-13 girls sit tests set by individual departments who have to agree before they are admitted. There are some bilingual students who speak a wide range of languages but English is the only language used in the classroom and all of these students are very proficient in English. There are about 830 students including a six form of about 200. There are no plans to seek grant maintained status at present. The school developed from a seventeenth century foundation.

This school is well known for its high academic standards. It has an impressive record of examination success at GCSE and A level. 96% of examination entries at GCSE resulted in grades A-C with 45% at Grade A. 97% of A Level entries resulted in grades A-E with 66% at grades A or B. The school retains a high proportion of its own students as members of the sixth form. Most students go on to University, some to Oxford and Cambridge. Students are well motivated to succeed with very supportive parents. This reflects the social background/culture of the catchment area. A small proportion of students are entitled to free school meals.

There is also a commitment to *the whole student*. The school aims to develop responsible attitudes to self and others and respect for cultures and beliefs. It aims to take advantage of its single sex status in order to encourage students' ambitions in all fields including those which have been traditionally male-orientated. Twenty per cent of the timetable in Years 10 and 11 is devoted to courses which are not examined at GCSE, including work towards a CREST Technology award. Students also have an opportunity to study subjects not included in the National Curriculum such as Latin, Drama and PSE.

In the Science Department there is no formal special needs policy for students with learning difficulties but efforts are being made to address the needs of the highest achievers. This is being tackled through provision of extension work. There is no departmental handbook as such but various policy statements are available. Copies of the safety policy, science department marking policy and the school brochure, including the aims of the school, are on file.

The girls study a combined science course in Years 7 and 8. The Nuffield Key Stage Three materials are used in this course and also in the co-ordinated sciences course which they follow in Year 9. In Year 10 girls choose between courses leading to Nuffield Double or Triple Award Co-ordinated Sciences. In the current Year 10, three classes study to Double Award and four classes study to Triple Award. Girls are taught in tutor groups of about 30 in the lower school and sets of about 24 in Years 10 and 11. These sets are mixed ability groupings within the top 15-17% of their year who are admitted to the school.

Classes are blocked together for Year 10 Co-ordinated Sciences (Double), so streaming is an option when they become Year 11. In Years 10 and 11 the girls have four double periods, of an hour and ten minutes, of Co-ordinated Sciences a week. This amounts to 20% of the curriculum time available for all students. The Science timetable in Years 10 is organised in blocks of five weeks. Girls study two science disciplines for two double periods each a week for five weeks and then change, so that by the end of the course they have followed each science discipline for an equivalent amount of time. This *modular* way of working may have reduced the effectiveness of the co-ordination between the sciences within the course. Nuffield Co-ordinated Sciences was adopted in 1988 in response to the call for broad balanced science whilst also maintaining a need to preserve the separate science disciplines.

The teachers follow the teaching schemes and style of the book quite closely. However, they do add ideas of their own where appropriate and leave out inappropriate material. The style of teaching varies between individual teachers and disciplines. There is a variation between the disciplines as to how much use is made of the textbooks. Teachers vary their approaches to suit particular areas of content. Wherever possible, teachers teach within their own discipline. However, some staff hope to offer more than one discipline in the future. The commitment to high academic standards and the academic potential of the students is reflected in the teaching styles adopted and the learning approaches encouraged. Part of this is an active approach to reading for learning which enables the girls to learn how to study using text. Generally the girls find the book difficult. If they are told to read a section without any questions, other guidance or structure, they may not get much out of the experience. The members of the department meet informally on a daily basis and discuss all aspects of their work, students curriculum etc. There are also regular formal Science Department meetings. There is a continual flow and exchange of ideas.

The school is well equipped with resources such as a library, computer systems etc. Nearly all science lessons are taught in large purpose built laboratories with fixed benches. The Nuffield Co-ordinated Sciences textbooks are supplemented by using other textbooks.

Appendix A

School Number 1028 (Pilot study and Main study)

This is a Local Authority, 11 to 16, five/six form entry, co-educational, comprehensive school in a town which is 7 miles from Peterborough. The school has been larger in the past. It is an established rural school and is the only secondary school which serves the town. Consequently, numbers fluctuate. At present the school is growing towards six/seven form entry in a few years time (1993/94) and possibly, eventually eight form entry. At one time this was a secondary modern school. It has had two changes in Principle in recent years (1993/94). The school has recently been inspected by Ofsted (March 1994, Ofsted contract number 905/S3/000349). A copy of this report which was made available is on file and was used in compiling this profile. The school loses a significant number of students to private education and semi local grammar schools. An application for Grant Maintained Status was refused in 1992/93. The students on roll include 10% more boys than girls in Years 9, 10 and 11 (1993/94). 10% of the students are entitled to free school meals and 6 have statements of Special Educational Needs.

There are some bilingual students, in particular, the children of people of Italian and Polish extraction. The children speak perfect *fen* [Crystal 1987 p. 30]. This is a distinct dialect with its own speech forms, words, word usage, mis-usage and different usage, for instance the use of *was* instead of *were*. This speech appears in children whose parents are not indigenous. The students are typical fen people although the town is becoming a dormitory town for Peterborough and is thus losing some of the *fen* character. More than 99.5% of the students are white. Students are given little systematic opportunity to consider and appreciate ethnic and cultural diversity within the curriculum (see Ofsted Report 1994a section 34 p. 13). However, the few students from ethnic minority backgrounds are well integrated into the life of the school with no evidence of discrimination. Equal opportunities issues have not been raised within staff forums recently (see Ofsted Report 1994a sections 107-110 p. 110).

Reading tests on entry indicate that students represent the full range of ability, including 15% who are more than two years ahead of and 20% who are more than two years behind their chronological age. reading standards overall are slightly above average but vary widely. Some students read widely for pleasure and many read set books and texts with understanding. Lower achievers do not enjoy books and their reading skills are not sufficient for them to access the textbooks in the Nuffield text books in Science or the textbooks used in Mathematics.

The catchment area is a wealthy town with a lot of small businesses. In the years up until 1993, most students had a job to go to when they left school. By 1994 this situation had changed and more students were seeking to continue in full time education at 16+ due to a lack of employment opportunities. 60% of the students who left in 1993 continued in full time education post-16. 89% of the 1992/93 Year 11 gained five or more grades A-G at GCSE. The school prospectus contains detailed information about examination passes 1992/93. There is a copy on file and further statistics are included in the Ofsted report. The proportion of students who achieved grades A-C at GCSE in 1992/93 is 29% and is below the national average (42%) but is not significantly below the national average for schools without sixth forms (34%). Girls achieved significantly better results at the higher grades than boys. Achievement at the higher grades improved between 1991/92 and 1992/93. The proportion of students who obtained a higher grade pass in all three core subjects is low at 15%.

The students are typically rural in outlook, attitude, motivation and horizons. They are very pleasant but lack some of the drive and initiative of city children (see also Ofsted Report 1994a section 22 p. 11). The fact that many do not need qualifications in order to get jobs with relatives etc. affects motivation. The main occupations in the area are based on agriculture and its products and the manufacture of bricks. The nearby city provides a very wide range of employment. The school enjoys good relationships with local firms through effective *industry days*, work experience and other links. Whilst unemployment in half of the catchment area is about average for Cambridgeshire, the other half experiences about double the county average and has a much lower than average proportion of high social class households. The socio economic circumstances of the students and their attainment on entry follow a "*fairly normal profile*" although there are slightly higher than average proportions of lower achieving students and those from less advantaged circumstances [Ofsted 1994a section 2 p. 2].

The Science Faculty Handbook was made available (1993/94). This includes various policy documents, including statements on Special Needs, Equal Opportunities and Multicultural Education, schemes of work and charts relating schemes of work and learning objectives to the relevant sections of the National Curriculum for Science. The next edition of the Faculty Handbook (1994/95) will reflect the outcomes of the Ofsted inspection. There is a cross curriculum group for syllabus co-ordination but no specific language policy across the curriculum. There is a brief description of Science courses in the school prospectus. There is a clear school policy on students with special educational needs but no Equal Opportunities policy. The Code of Conduct includes procedures for rewards and sanctions and there is a homework policy but there is no school marking policy.

The Science Department is quite well resourced. Most Science (1992/93), all Science (1993/94), is taught in purpose built laboratories. The Department is well supplied with sets of several textbooks. The students tend to look after textbooks and this has resulted in an extensive accumulated stock of varied material. Every student taking the course is issued with a copy of each of the three Nuffield Co-ordinated Sciences textbooks. There is a mixture of language support provision, some by withdrawal, some in the classroom (see also Ofsted Report 1994a sections 111-114 p. 27). In the unofficial Ofsted feedback the use of learning support staff within the Department was described as "*effective*".

Class size varies with intake and intake varies because this is the only school in the town. Students are set on their ability in Science within two half years based on Maths groupings. One half year is more able at Maths than the other. However, one of the Ofsted findings was that students achieved more when they were taught in mixed ability groups. The Science Department has a policy of making the classes including more able students larger (about 30) than classes with less able students (about 24). These class sizes exist throughout Key Stages 3 and 4. There is no particular teaching policy but regular contact between colleagues ensures continual sharing of ideas and approaches. All teachers teach within their own discipline. In addition some teach outside their discipline (1993/94). This is the result of expediency rather than a conscious policy decision.

The Department adopted Nuffield Co-ordinated Sciences in 1988. It was seen as way of introducing broad balanced Science yet retaining separate science disciplines. This course replaced a system where some students chose two out of three sciences and others did NEA Modular Science. All students follow the Nuffield Co-ordinated Sciences course in Key Stage Four (1992/93, 1993/94). One reason for choosing Nuffield Co-ordinated Sciences for all students was the low status of modular courses within the school which contributed to the failure of NEA Modular Science. Students also follow the Nuffield course in Key Stage Three. These schemes of work follow the Nuffield materials quite closely with some input from other sources.

The Ofsted inspection of the Science Department found that few students at Key Stage 4 reach high levels of achievement in lessons and described the GCSE results as "*poor*", being well below county and national averages. Where progress is unsatisfactory students are over-reliant on the teacher, have little understanding of how to proceed and lack confidence or initiative. Teachers rely too heavily on the standard text and worksheet and have little guidance from the management beyond the published scheme. The texts and worksheets are not always fully accessible to students with limited reading capability and are not sufficiently differentiated. The unofficial feedback was also critical of the layout of the textbooks saying that it was not "*differentiated, inhibiting students' progression*". All these comments suggest inadequacies in the Nuffield Co-ordinated Sciences texts (See Ofsted Report 1994a sections 49-53, 102, 125). However, students were thought to have a "*sound basic knowledge of the scientific terms needed*".

From Year 10 1994/95, students of the lowest ability will follow a course based on *Science at Work* (see also Ofsted 1994a section 12 *Key Issues for action* p. 9). This decision was taken because teachers are dissatisfied with the Nuffield Co-ordinated Sciences course materials in use with these students. They are looking for something which is, *more user friendly*, *more readable*, *more child centred* and *more relevant* for them. Also the students' attitude towards modular courses has changed. The Department have a motivation problem with less able students (see also Ofsted Report 1994a sections 20 & 21 p. 11). This reflects a change in attitudes in the students and the requirements of employers. There are fewer skilled and semi-skilled jobs available in the area.

20% of the curriculum time available in Key Stage Four is allocated to Science. Students are taught in 50 minute periods. Six of these periods are allocated to Science each week.

Appendix A

Within the Science Department the disciplines are well co-ordinated through regular formal and informal meetings. The Science Department are happy with the Nuffield Co-ordinated Sciences course for able students and see it as a good preparation for A Level.

10 X3, the class participating in the pilot study, is a class at the lower end of the ability range with a mixture of those who can read and those who can't. These are not particularly well motivated students. It may be possible to organise some language support for all, or part of, the task (this was not possible).

The Head of Science and Head of Biology expressed an interest in expanding the work of the project (1992/93) to include the Nuffield Co-ordinated Sciences Biology Worksheets. They considered that this might be a bigger problem area, regarding the readability of texts, than the textbooks. They have alternative materials which they can use instead of the books. It is more difficult to find alternative worksheets yet still follow the Nuffield Co-ordinated Sciences course.

The Head of Science in this school is a user group organiser for Nuffield Co-ordinated Sciences.

Appendix A

School Number 1029 (Main study)

This is a five form entry 11-16, (Special Agreement) Church of England, co-educational comprehensive school in rural Lancashire. (Special Agreement) means that, although the school is funded equally by Church and State, it is under Church control. The school role is limited to 704 students. The intake in 1994 is limited to 150. A new building programme in 1994 will provide facilities for growth and expansion (new building occupied February 1995). The school serves thirteen ecclesiastical parishes in the area, five of which are foundation parishes. Students are admitted following rules set out in the school prospectus a copy of which is filed. These rules were devised by the governors and are specific to this school. Priority is given to those who live in the foundation parishes and then the other parishes, to churchgoers and those who identify the school as their first choice. It seems unlikely that the school will seek grant maintained status at present (1994). The students have distinct Lancashire accents and some speak in dialect [Crystal 1987 p. 30]. Very few schools in Lancashire use the Nuffield Co-ordinated Sciences course.

The students are a mixture of those whose families have lived in the area *since the Domesday Book* and incomers who live on the new housing estates in villages. They are pleasant, laid back, unsophisticated children from a wide range of social backgrounds. There are no urban students at all. A very small percentage of students (maybe 2-3%) are entitled to free school meals. Motivation is a problem, There is not the competitiveness found in other groups of children. Many have rural jobs to go to or will work with a parent. This reduces their need for paper qualifications. They consequently take their full quota of days off school.

The number of students gaining 5 or more GCSE passes at grades A-C has steadily increased over the period 1988-1993 from 25.5% to 45.5%. Of the students who left Year 11 in 1992, 70% went on to further education in the sixth forms of local schools and colleges, 14% entered YTS schemes, and 8% entered permanent employment. This school has the best employment record of the local schools. There are still some big employers locally.

The management of the school are proud of their Christian ethic and ethos which is at the heart of the life of the school. The school has close links with the local Anglican clergy who meet regularly as a Chaplaincy team to plan the church worship of the school and who frequently lead assemblies. The school has close links with their Diocesan Council for Religious Education and Diocesan Director of Education. The school has a *quiet room* for religious observance, discussions and prayer.

The school is developing a whole school approach to Special Needs Education. Special Needs staff provide support both inside and outside the classroom for students with specific learning difficulties. The Special Needs Department also draw on outreach support for help with MLD students, those with emotional and behavioural difficulties and those coping with English as a second language. A team of parent helpers assist the Special Needs Department by supporting individual students. The Special Needs Department also work with staff from special schools and other relevant professions to support students with physical disabilities. Three teachers are attached to the school on a full time basis to support students with statements of Specific Learning Difficulty. There is quite a lot of in-class support in science lessons. They are also involved in helping to develop classroom materials, some work on differentiation and review sheets.

The students are taught in double lessons of 65 mins each and single lessons of 30 mins or 35 mins. General Science is taught in 5 mixed ability Tutor Groups in Year 7. It is allocated 5 periods a week. Year 8 are taught as six classes in three ability bands and are allocated 6 periods of General Science a week. These classes are taught as half years linked to setting in other subjects. Year 9 are setted into 6 sets by ability in Science and are taught separate Sciences. They are allocated 6 periods of Science. Nuffield Co-ordinated Sciences is taught to all students in Years 10 and 11. One option group follow the Triple Award course and are allocated 12 periods of Science a week. The 8 periods of Science allocated each week to the five Dual Award groups at Key Stage Four amounts to 20% of the time allocated to the whole curriculum. These five groups are setted on ability. The classes in Years 7 and 8 and in the top end of Year 9 consist of about 30 students. In Key Stage Four classes are limited to less than 24 students.

As a Nuffield School *through and through* the Science Department have always placed an emphasis on the practical *learning for yourself* approach to teaching and learning. The team is very strong and where possible, tries to be innovative. As part of the TVEI the school has been involved in a teaching and learning styles project. The Department is interested in student centred activities. They will try anything and there is no strict policy about approaches. Colleagues discuss the curriculum regularly both informally and formally and exchange ideas and teaching strategies.

Colleagues might introduce a piece of text by reading it through with students. They also use *read and do* exercises but the whole Department are aware of the limitations of the Nuffield Co-ordinated Sciences textbooks. They would criticise the presentation of the material as much as its content. However, there is a wide variation in the amount of use of the books between individual members of staff. They use alternative texts such as *Biology for All* and Mackean. The books are not issued to students on a permanent basis. There are stocks of the Nuffield Co-ordinated textbooks which can be borrowed for short periods. When the Department offered an exchange and sales service to students, Nuffield Co-ordinated Sciences textbooks were returned after two years virtually unused. The Department have not bothered to invest in copies of the Nuffield Co-ordinated Sciences earth sciences book.

The Science block consists of four well equipped laboratories. There have a mixture of fixed and moveable benches. There is a smaller teaching room, a new Science IT equipped with seven computers and a central preparation room. They also have a CD-ROM. A refurbished laboratory became available from September 1994 but at the moment (Summer 1994) quite a few lessons are not taught in laboratories.

Appendix A

The Science Department provide students with profile or syllabus booklets which enable then to plot their own progression through the course by ticking off National Curriculum statements of attainment as they are accessed in the course. As statements are achieved the ticks are endorsed by the teacher's initials. The National Curriculum statements are presented to students as *can do* user friendly statements. Statements are classified as *Basic*, *Central* or *Further* (a copy of the Biology booklets is on file). They intend to refine this system further using a system which they have developed with Key Stage Three students by using topic sheets which include vocabulary lists, glossaries of terms, user friendly statements and review sections, which will be handed out at the beginning of each topic. The Science Department accept their responsibility to teach the language of Science to students. The glossaries focus attention on key words (copies of examples of these Key Stage Three sheets are on file).

The Science Department adopted Nuffield Co-ordinated Sciences in 1988 in response to the call for broad balanced Science. They have a long tradition of using Nuffield courses and the Nuffield approach. They place no more emphasis on *co-ordination* than they did when they taught separate sciences. There is a Science Department policy of teaching subject specialisms. Most colleagues are happy teaching two science disciplines.

A copy of the Science Department Handbook was made available and is on file. It is about to rewritten. This includes useful information such as Science Department personnel and a copy of the timetable. However, I was warned that some of the information in it is out of date. There is no defined *Language across the curriculum* policy.

There is a possibility that the school will drop the Nuffield Co-ordinated Sciences course for Year 10 1994/5 (This did not happen following *much improved* examination results in 1994). This might provide some useful opportunities for information collection. The problem is a dissatisfaction with examination results. The school is *in the marketplace* with league tables and local schools using other courses, particularly modular courses, are achieving better examination results at GCSE. The Department complained about the lack of moderation between courses and the form of the examination rather than directly criticising the Nuffield Co-ordinated Sciences course.

The Science Department have *grave reservations* about the Nuffield Co-ordinated Sciences texts and use them less and less. They often rewrite the worksheets (I have examples of these versions on file). At Key Stage Three they have written a course of their own based on the Nuffield Key Stage Three materials. They also use cloze techniques quite a lot in their normal teaching.

Appendix A

School Number 1031 (Main study)

This is a five form entry, Voluntary Controlled, LEA 11-18 County boys' selective grammar school in Kent. The school has 863 students, including about 160 sixth formers, and is expanding from four to five form entry. The admission of Year 7 students is administered through the County selection procedure conducted annually by Kent Council, or in the case of students living outside Kent, through an equivalent procedure in their own county. Older students are considered for entry into other year groups following application to the Headteacher or the Area Director of Educational Services. A small number of girls were admitted to the sixth form in September 1993. There is co-operation at sixth form level with the neighbouring girls' grammar school in some courses and in various musical, sport, drama and *out of school* activities. The school is popular and the roll increasing while maintaining the quality of the intake. The area includes populations of high social class groups and people with economic disadvantage [Ofsted 1995c p. 2]. The school serves an area with several housing estates. The students are pleasant and generally well motivated. The school prospectus, a copy of which is on file, includes a short history of the school and its founder. The school offers students the opportunity to sit GCSE in up to 10 subjects. The school was inspected by Ofsted during the study (during the Summer term of 1995). A copy of the report on this inspection is on file and was used in compiling this profile [Ofsted Report June 1995 under contract no 922\S4\001650].

About 8% of the school's students are bilingual. These are mainly Hindi and Panjabi speakers, the majority of whom were born in this country. The school is popular amongst "*ethnic families*" [Ofsted 1995c p. 2]. Teachers in the school consider themselves *colour-blind* and find that these students are generally amongst the *better children*. The bilingual students are well motivated and well integrated. The school offers Hindi and Panjabi at GCSE alongside Latin, German, French, Spanish and Greek. However, it is assumed that all students are competent users of written and spoken English and there is no particular provision for speakers of community languages. 4.8% of the students at the school are entitled to free school meals.

The school was founded as a free school in 1701. The school's endowments are administered by a separate governing body, formed from community representatives in accordance with the school's Scheme of Government. In addition, the school has governors who handle the general management of the school as in any other Local Authority school. The school has strong links with the community through its history as a free school. A wish to maintain these links has influenced the governors' decision not to seek grant maintained status (1993/94). The school has links with various companies including G.E.C., AKZO Chemicals, The Wellcome Foundation and Southern Science Limited, who offer sponsorship for scientific projects.

This school is justifiably proud of its academic traditions. Of the students in the 1993/94 Year 11, 97.6% continued there education in school or further education. Of the 1993/94 Year 13, 81.1% entered Higher Education while a further 5.4% continued in Further Education. Of the 1993/4 Year 11, 100% achieved five or more grades A-G at GCSE, with 95.1% gaining five or more grades A-C. This is well above national and county averages [Ofsted 1995c p. 6]. Employment prospects in the area are poor, a factor which may contribute to the high staying on rate.

The school has a policy on Special Educational Needs including the education of very able students, and provision for those with physical and other disabilities, for example there is provision for hearing impaired students. Emotionally disturbed students and those whose are behaviourally challenging are dealt with through the school's Pastoral Policy. The school has a designated co-ordinator for special educational needs. Their role is liaison with outside agencies and between staff and to develop resources and strategies. The school aims to identify students with special needs as soon as possible. Assessment follows the DFE code of practice. The policy sets out possible strategies including a referral system (trialled in 1994/95). Staff Development in the area of Special Needs is a priority for 1994/95. The policy also identifies strategies for use with very able students and confirms the value of the partnership between home school and students. A copy of this document is on file (1993/94). There is a commitment to full curriculum entitlement for every student.

Science Department policy statements, including samples of schemes of work and aims and objectives, will be made available (1993/94). Copies of two recent documents, a Curriculum Statement for Science including aims and objectives and a Science Department Open Evening leaflet are on file (1993/94). A school equal opportunities policy is also being developed. There are no formalised language policies within the Department or the school.

The school day is divided into four double periods of an hour and fifteen minutes each, each consisting of a period of 35 minutes and one of 40 minutes. Two double periods are allocated to Science in Years 7 & 8. These students follow a *home grown* course based on the Blackwell Modular Science Scheme. Three double periods are allocated to Science in Year 9. The Department aim to develop a new scheme of work for this year group based on separate courses in the science disciplines and using recently published *end of Key Stage Three materials*. Four double periods are allocated to Science at Key Stage Four. This amounts to 20% of the curriculum time available for this Key Stage. All students follow the Nuffield Co-ordinated Sciences Double Award course at Key Stage Four.

At Key Stage Three, students are taught as mixed ability Tutor Groups of between 28 and 32 students. At Key Stage Four, although it is a compulsory core subject, Science is timetabled within an options scheme. One outcome of this arrangement is that it is not possible to set students completely by ability in Science across the whole ability range. Classes are setted within two blocks of classes. Setting is based on students' performance in Key Stage Three SATs. This works very well (see School Number 1018). This system enables a certain amount of *banding*. These classes consists of between 22 and 25 students. Differentiation is *an area of discussion* within the school. Even though this is a selective grammar school with a good academic record, the Department come up against a wide range of ability in

Science including some boys who have a great deal of ability in Science. These students should be extended "*a long way above the book*". They tend to use other texts as well. Such study skills should be developed in such students. Most of the boys have access to a range of alternative texts at home. Other students have difficulty understanding the Nuffield Co-ordinated Sciences texts.

It is the policy of the school and Department to emphasise the separate nature of the sciences. This policy is clearly stated in the Open Evening leaflet on file. The Curriculum Statement for Science talks of "*the distinctive place of the Sciences within the school curriculum*".

The school adopted Nuffield Co-ordinated Sciences in 1988 in order to provide a broad balanced science course which preserved the separate nature of the science disciplines. The Key Stage Three scheme includes distinct Physics, Chemistry and Biology modules. The Department put off introducing the Triple Award course in September 1994 and will wait for the results of the Dearing Review. Eventually, they will probably offer what amounts to 20% Science overall but packaged as Triple Award for one class, Double Award for say, three or four classes and Single Award for one class. Electronics is offered as an out of school activity. Physics with Engineering and Electronics are offered as sixth form courses alongside the standard diet of A Level Science courses.

Individual teachers are left to decide on the appropriate teaching approaches and styles necessary to deliver the particular content in which they have expertise. However, it is also acknowledged that choices of courses and teaching materials by senior members of the Department is, to some extent, an indication of the type of teaching which is expected and is likely to occur. The students in this grammar school are probably able to cope with, and benefit from, a more *traditional*, more *didactic* style of teaching than is found in some of the schools participating in the study. The teachers in the Department are mature and competent and have developed effective teaching methods for this teaching situation. The need to write up experiments formally has been reduced with the implementation of the National Curriculum but the Department still expects students to write in a scientific style using formal language. It is likely that text is introduced to students by everybody in a class reading some text and then the class discussing questions together before individual students work on their own individual responses.

Teachers teach subject specialisms but, if there was an opportunity to appoint new members of staff, the Headteacher would probably look for people who were more flexible, offering perhaps two branches of Science (1993/94). Key Stage Four classes are allocated one double period of each science discipline, each week. The fourth double period is offered on a rota system, where teachers teach, or take free periods, in turn. This ensures the equal allocation of time to each of the three science disciplines. A copy of a sheet setting out this rota system is on file. The system ensures the availability of a science specialist for cover in this part of the timetable and facilitates some team teaching. It is also possible for colleagues to work together on assessments and projects for Science AT1.

The school is well equipped with computers and the Science Department is soon to be included in the school's computer network (1993/94). The Department plans its own *cluster* within this network. The Biology courses are well resourced in other ways. For instance there is a large, well equipped, greenhouse on site. The Science Department possesses class sets of various text books which can be used as alternatives to the Nuffield Co-ordinated Sciences texts or to complement them. Each Key Stage Four student is issued with copies of each of the three Nuffield Co-ordinated text books at the beginning of Year 10. However, "*some textbooks are approaching the end of their working life*" [Ofsted 1995c p. 29]. Every science lesson is taught in one of seven purpose built laboratories. The Department hopes to have a seminar room converted into a sixth form laboratory in the near future (1993/94).

The rooms are adequately equipped and are a mixture of some with fixed benches, others with movable benches. To some extent the accommodation reinforces the commitment to separate Sciences. For instance, the Chemistry rooms are well equipped with fume cupboards but have very few power points. I counted four fume cupboards and only three power points in one large Chemistry laboratory. The technician remarked to me that this made work on electrolysis very difficult. On the other hand, the Physics laboratory had no fume cupboards but was well equipped with power points. The accommodation is quite old (sixties) but well cared for. It is "*reaching the point at which refurbishment is necessary*" [Ofsted 1995c p. 16].

The Head of Science, Mr. James, is a member of the National committee for Nuffield Co-ordinated Sciences. He is a regional secretary and user group organiser. He suggested that some feedback from his liaison with other Heads of Science suggested that there was more dissatisfaction with the Biology text than the other books published in the course materials. He is also on a SCAA committee concerned with the administration of SATs.

The Head of Biology criticised the biological content of examination as being too concerned with data handling rather than *real Biology*. He also enumerated some of the problems of coping with Science AT1 within biological investigations. This has also affected his use of the worksheets. He uses fewer of them in their original form, preferring to adapt them to fit the requirements of and style of Science AT1.

The students in the school are addressed by their surnames.

Appendix A

School Number 1035 (Main study)

This is a Hertfordshire five form entry, 11-18 co-educational comprehensive school which has 880 students including 140 sixth formers. The school was a grammar school until 1968. The school is generally oversubscribed and places are allocated according to the Hertfordshire rules. The students are generally pleasant. There are some bilingual students but most of these are competent speakers of English. All instruction and conversation in the school is in English. The sixth form is organised on a consortium basis with other local secondary schools but the school preserves its own science A Level provision. There is no question of the school becoming grant maintained within the foreseeable future (1993/94). However, the situation is regularly reviewed.

The school has been recently inspected by Ofsted. A copy of the inspection report (353/93/SZ) was used in compiling this profile and is on file [Ofsted 1993b]. Other documents which were made available were the school prospectus, a copy of which is filed, the school curriculum statement and the science faculty handbook. The entitlement to free school meals is less than 5%, below that of Hertfordshire and for other shire counties. Students are drawn from relatively prosperous areas and from areas of average prosperity with a minority of students from deprived backgrounds. The school has an unusually high proportion of male students (in 1993/94 the boys/girls ratio was 1.3:1) because there is an imbalance in single sex provision in the locality in favour of girls (two girls' grammar schools). This situation has gradually developed. If we examine intake years, the situation changed from 1.1:1 in 1974, to 1.13:1 in 1984, to 1.17:1 in 1989 to 1.3:1 in 1993, to a projected 1.5:1 in 1994. One explanation of this shift is the effect of league tables on parental choice of school. The Year groups studied are the 1989 and 1990 intakes. The loss of able girls may have a serious impact on the school in the long term, beyond the scope of this research.

The students are generally well motivated. Parents have high expectations and are supportive of both their children and the school. For many years the students' prospects on completing compulsory schooling have been good. In 1992 over half the students completing Year 11 returned to the school as sixth formers. Another 28% entered full time education elsewhere. Only 4% were unemployed. Out of the 62 students who completed Year 13 in 1992, 42 went on to higher education and only 1 was unemployed.

The school curriculum statement includes policy statements on a range of issues such as special needs, school organisation and equal opportunities. The special needs document identifies the needs of those who are academically most able as well as those who have learning difficulties. The special needs departments provides excellent support for students with learning difficulties. Strategies include withdrawal and support within the classroom. The Head of Special Needs does some classroom support teaching in Science. The faculty also benefits from help from sixth formers, especially with Year 7 classes. There is no defined policy on language, but this is being developed.

Appendix A

The faculty handbook contains useful information about alternative teaching strategies, schemes of work, and marking, assessment, appraisal and safety policies. The document outlines some faculty teaching aims and good practice. It helps to provide consistency in marking and teacher expectations. In this faculty it is the responsibility of the individual teacher to select teaching strategies appropriate to a particular group of students and subject content. They are encouraged to use the handbook and colleagues as sources of ideas, encouragement and examples of good practice. The faculty meet informally on a daily basis and discuss approaches and curriculum developments. Individual styles and strategies vary a great deal. In practice there is more similarity between the teaching offered by different teachers at Key Stage Three than higher up the school simply because that particular teaching scheme prescribes strategies to a certain extent. The school is pushing towards whole school policies on matters such as teaching style and strategy. Most teachers within the faculty teach within their subject specialism in Years 10 and 11 and beyond. Nuffield Co-ordinated Sciences was introduced in 1988 in response to the call for broad balanced science whilst recognising the need within the faculty to preserve subject specialisms.

Text is introduced using a wide range of strategies. Class time is generally taken up with practical work. Students tend to read the text at home. There is some teaching in the use of text and how to study from text. There is also some teaching about science language and text development.

Students are taught Science in mixed ability Tutor groups of about 30 in Years 7 and 8. In Year 9 this is changed to six sets of about 25 based on the results of module tests and teacher impression. Sets are then rearranged at Christmas after a test and with adjustment for gender balance. These three year groups follow an integrated science course which uses the Nuffield Co-ordinated Key Stage Three material.

In Years 10 and 11 all students follow the Nuffield Co-ordinated Sciences Double Award course. They are taught in sets arranged on ability, with some adjustment for gender, of about 25 students each, with slightly more students in the lower sets. In the current Year 10 there are 7 sets. The set involved in the pilot study 10S3, is one of the middle sets within this scheme. In Years 10 and 11 Science is allocated four double periods of an hour and ten minutes each, per week. This amounts to 20% of curriculum time for all students. The course is taught within a rota system with one double period for each discipline and a rostered period which changes between the disciplines on a fortnightly cycle, each week. The outcome is that students are taught the three disciplines for an equivalent amount of time within the whole two year course. Faculty members look forward to a time when the timetable is organised to give students in Year 10 and 11 six 50 minute periods of science a week.

All science lessons are taught in large, spacious, purpose built laboratories with fixed benches. The Department boasts several spacious prep rooms with generous room for storage. Resourcing is not particularly good but the faculty have items such as video machines and computers. The cost of buying the Nuffield books has been a financial burden on the faculty in recent years. Each child takes home their own set of textbooks and each department within science uses other textbooks to supplement the Co-ordinated text. The Biology Department uses mackean and Roberts for this purpose but tends to stick to the Co-ordinated book for most of the time. Other resources are prepared as photocopied sheets.

The Head of Science, Alastair Sandiforth has been actively involved in revisions of the Nuffield Co-ordinated Sciences Biology content, working on the New Editions of the Biology text, the Earth Sciences text and the Teachers' Guide. He is an examiner and question writer. He edited and wrote work sheets for the Triple Award Biology course and was actively involved in work on the Nuffield Key Stage Three material.

Appendix A

School Number 1036 (Pilot study and Main study)

This is a ten form entry, split site, 11 to 18 mixed Roman Catholic comprehensive school in Walsall. In June 1994 there were 1377 students on roll. It is an established school which is generally oversubscribed and takes students from a wide catchment area containing over fifty primary schools. Local children go to various schools. Although the area where the school is located contains above average levels of social deprivation, this is not reflected in the school population. The admissions policy and procedures are set out in the school prospectus, a copy of which is on file. Roman Catholic children and those attending Roman Catholic primary schools are given priority. Those with siblings already in the school and some non-Catholics requiring Christian education are also admitted. The school became Grant Maintained in 1992. Classroom discourse is conducted in a distinct regional accent but there is no noticeable use of a regional dialect [Crystal 1987 p. 30]. The school was founded in 1973 by the amalgamation of two schools on either side of a main road. The two sites are connected by a bridge. This causes various problems. One solution tried in 1993/4 was to timetable lessons in half day sessions.

The school was inspected by Ofsted during the study (during the Summer term of 1993/4). A copy of the report on this inspection is on file and was used in compiling this profile [Ofsted Report June 1994 under contract no 335\S3\000672].

Students' backgrounds range from those suffering from the effects of long term unemployment to professional families. About 50% of the students are from single parent families or families where one parent has remarried. About 7% of the school population is of ethnic minority origin with about 5% from homes where English is not the first language. 19% of students are entitled to free school meals. There were five students who have statements of Special Educational Need in June 1994 [the statistics used in this paragraph are quoted from the Ofsted Report 1994b sections 2 & 3 pp. 4-7].

The school has a reputation for good discipline and orderly students. It has a distinctly Christian ethos, mission and philosophy (see *Introduction* and *Pastoral Care Policy* in the school prospectus).

"*The school is essentially Roman Catholic in all its teaching and ethos..* [school prospectus, Introduction].

The school has its own chapel where daily assemblies and weekly Masses are held.

The school has its own off-site residential centre, a former Junior school, in Hereford and Worcester. Year 7 and 9 students follow project work and outdoor pursuits at the centre.

In the 1992/93 Year 11, 96% of all students were entered for and gained at least one GCSE and 35% gained five or more grades A-C. Girls did better than boys. 94% of students gained five or more grades A-G and 64% gained at least one grade A-C. These figures are comparable with local and national averages as were the examination results at Advanced Level. In 1993 80% of the students stayed on in full time education at 16 and 75% went on to Further and Higher Education courses at 18 [Ofsted 1994b sections 15-23 pp. 12-13]. Those that do leave to gain employment generally find jobs relatively easily, in part due to the school's reputation. It is an area with a tradition of manufacturing industry but unemployment is quite high. Of the Year 11 leavers in 1993 only 5% remain unemployed, of the Year 13 leavers only 7% remain unemployed (see school prospectus *Exam results and school leavers destinations - 1993*).

The science policy is available (copy on file) and includes a statement on special educational needs (see also Ofsted 1994b sections 162-170 pp. 36-38). The school Special Needs Policy is set out in the school prospectus. The policy accepts that students with special needs should have access to the full curriculum and should be enabled to fulfil their full potential. The school seeks to achieve these objectives through the activities of a staff committee called *The Learning Extension Group*. Where possible, Special Needs help is provided within regular classes rather than by withdrawal. The students concerned are closely monitored and their progress is reviewed each term. Some subjects, not Science, operate a policy of accelerated groups of students who take their examinations a year early. There is a language policy across the curriculum.

Overall, numeracy, reading and writing standards and standards of oracy, in Key Stages Three and Four are satisfactory [Ofsted 1994b sections 24-27 pp. 13-14]. The quality of learning is satisfactory or better in over 80% of lessons [Ofsted 1994b sections 28-33, 74-75 pp. 13-14 & 21]. In 1993 the percentage of students gaining grades A-C in Science was below the national average for Double Award Science examinations whilst those gaining A-G was slightly above national averages.

The Science Department is not particularly well resourced but moved into a new science block containing six new laboratories in 1994. Spending on teaching staff, books, materials and equipment is below local and national comparators. Students are taught up to half their science lessons in classrooms. Some classes are taught in small rooms designed for use with sixth form classes. There is an imbalance in the specialisms of science staff and some inefficiencies in their deployment, insufficient technical assistance, and an inadequate amount of equipment to support the science curriculum. On occasion, resource deficiencies limit the range of teaching styles used.

"Deficiencies in resources and accommodation are having a detrimental effect on standards and quality in science." [Ofsted 1994b section 77 p. 22]

At Key Stage Four, students study blocks of work in the science disciplines on a roundabout system changing every four weeks. Some find this unsettling. Each student is only issued with a copy of the text book linked to the block of work which they are currently studying due to a lack of textbooks. Textbooks are exchanged at the change over between blocks. There are a limited number of other sets of texts available but nothing much which is suitable for the SEG Modular Science course which was studied by the lesser able of the two bands of students up until 1993/4. There is a limited amount of language support provision in the classroom. Class sizes vary. In the 1992/3 Year 10 groups consist of about 22 but in 1993/4 this was about 24. Classes in the Lower School are bigger (in Year 7 averaging 30).

There is no particular teaching policy within the Science Department but the department policy document stresses the need for variation in teaching styles. Teaching and learning are traditional in form. Members of the Science Department expect the changes in the school day (1993/94 mentioned above) to encourage new teaching styles. All teachers teach within their own discipline.

The school adopted Nuffield Co-ordinated Sciences in 1988. In the 1992/3 Year 10 six classes took Nuffield Co-ordinated Science and five classes took SEG Double Modular Science (this replaced MEG Syllabus D). The more able students took Nuffield Co-ordinated Sciences. The Department were dissatisfied with the SEG course and were unhappy about running two courses. They looked to extend the Nuffield Co-ordinated Sciences course across the whole ability range using the new syllabus. This was achieved in 1993/94 Year 10.

The school is banded as two half schools, a high ability band and a low ability band. In Key Stage Four 1992/93 the Science Department taught the higher ability band who take Nuffield Co-ordinated in six classes, all at one time. 10P 1992/93, the class involved in the pilot study, were the second class down in the higher ability band. They were pleasant, but not particularly well motivated, students. In Key Stage Four students are taught Science in four 70 minute lessons each week. This amounts to approximately 20% of the total curriculum time available for these students.

The Head of Science and Head of Biology expressed an interest in expanding the work of the project to include the Nuffield Co-ordinated Sciences Biology Worksheets. They considered that this might be a bigger problem area, regarding the readability of texts, than the text books. They have alternative materials which they can use instead of the books. It is more difficult to find alternative worksheets yet still follow the Nuffield Co-ordinated course.

Appendix A

School 1039 (Student interviews)

This is a ten form entry, 12-18 co-educational, grant maintained comprehensive school in Buckinghamshire. The school is located on a large site with two separate buildings which are about 300 metres apart. It is situated on the edge of an expanding urban area and students live in a mixture of modern private housing, local authority accommodation and Victorian terraced properties. This is an established school with a good reputation, in competition with newer schools with more modern accommodation. The most recent Ofsted report [1993c p. 2] on the school describes the wide range of socio-economic backgrounds of the students. Although the Ofsted report describes the school as "*well subscribed and well regarded by parents*" [Ofsted 1993c p. 2], student numbers have fallen gradually in recent years, mainly for demographic reasons. In 1993 there were 1728 students on role with about 365 students in each year group of compulsory school age. The school has established links with the local community through community service and charity efforts. It is associated with the local Training and Enterprise Council and has been involved in a number of curriculum projects in partnership with local employers. The six-weekly newsletter is distributed widely to local businesses, libraries, schools and health centres. There is a large uptake on the Duke of Edinburgh Award Scheme and the school's steel band has achieved local and national prominence. Travel bursaries are provided by the PTA. There is a good uptake on this scheme and students' proposals are well researched and presented. In 1993 there were 48 students at the school with statements of special educational needs and about 15% of the students attending the school were entitled to free school meals.

Of the 1995/96 Year 11, 93% were entered for five or more GCSEs, 28% achieved five or more grades A*-C and 87% achieved five or more grades A*-G. The Ofsted report [1993c p. 29] draws attention to the gender imbalance in the GCSE results for 1992 and 1993 in favour of girls, with boys achieving below national averages. This is still apparent in the 1996 results. GCSE results in Science are below the national average. Of the 1992 Year 11 leavers, 65% stayed in full time education, 14% found employment, 12% went into training and 10% did other things. The A Level pass rate in 1996 was 85% with an average point score per pupil of 15.1. Of the 1996 Upper Sixth leavers, 85% went into Higher Education.

Copies of the Ofsted report [1993c] and school prospectus were made available for writing this profile and are on file. The school prospectus includes policy statements on Special Education Needs and Equal Opportunities and an Anti Racism policy. The admissions policy is also set out in the prospectus. If the school is oversubscribed, the main criterion for admission is the distance between the prospective student's home and the school. The Ofsted report mentions a school language policy [Ofsted 1993c p. 27] which was described by one teacher as an unwritten policy for *Language across the Curriculum.* The Science Department Handbook is a lengthy document which quickly becomes out of date. A copy was not available. This handbook includes various departmental policies and information about the courses offered and safety matters etc.

The Ofsted report [1993c p. 2] recorded that 4% of the students attending the school were of ethnic minority origin. However, a recent influx of Hong Kong Chinese families to the area has helped to increase this proportion to about 10%. Ofsted [1993c p. 30] reported that the majority of the ethnic minority students had an Asian background and that the school qualified for a full time equivalent Section 11 teacher. This post was filled at that time by two part time teachers, one of whom was an Asian language speaker. It was clear that students benefited from the support given by the Section 11 teachers. Ofsted [1993c p. 30] identified a need for staff development and in-service training to extend their expertise in dealing with ethnic minority students.

Judged by the prospectus, there is no provision for students to sit examinations in ethnic minority languages at GCSE or A Level. There was no evidence of particular links with ethnic minority communities. However, RE courses include work on world religions and cultures and various religious festivals are mentioned in assemblies, as and when this is appropriate. The approach was described by one teacher interviewed as *integrated*. Within the Science Department, catering for ethnic minority students is treated as a Special Needs issue. Science benefits from Special Needs support for bilingual students. One teacher in the Science Department has special responsibility for Special Needs within Science. Ofsted [1993c p. 18-19] describe the Special Needs provision within Science as, "*well documented and well planned*". When choosing textbooks, Science Department members take into account the need for pictures and examples in the text concerning people of other cultures.in order to provide for ethnic minority students (*Biology for Life* and the new Pople Key Stage Three text were described as being particularly good in this respect.).

The Science Department has 14 laboratories and 12 teaching staff. In addition, a member of the Senior Management Team is a Science specialist and advises on management issues within the Department. Although the Ofsted report [1993c p. 18-19] was complimentary about standards of teaching and learning within the Department, with achievement in most cases average or above, there was comment about a lack of attention to scientific investigation. One of the teachers interviewed pointed out that restrictions on resources such as photocopying and a lack of certain items of equipment makes this teaching approach more difficult to implement. In fact, a restriction on resources has led to a more didactic teaching approach within the Department in recent years.

The Department is in the process of rationalisation on one part of this split-site school. This exercise has involved the conversion of three English rooms into laboratories and the refurbishment of other science rooms with recycled furniture and equipment. There are various room arrangements, some laboratories have fixed benches and others have island units. Some of the laboratories are quite small, especially for use with large classes. The Ofsted report [1993c p. 19] was critical of the science accommodation and the provision for Information Technology within Science.

Appendix A

The Department is well stocked with sets of various textbooks but does not possess enough copies of the Nuffield Co-ordinated Sciences textbooks to issue the three of them to all students for the duration of the Key Stage Four course. Consequently, the textbook studied is used almost exclusively in class with double award sciences sets. However, each Biology teacher has the use of a class set of the Biology textbooks and could issue them to students for short periods if this was appropriate. The drawback in this arrangement has been a problem with getting textbooks back from students within a system of science subject lesson rotations. The school has only the old edition of the Nuffield Co-ordinated Sciences Biology textbook. *Biology for Life* is preferred for use with Key Stage Four students and *Living Things* is also used with these groups. Each Biology teacher has exclusive use of sets of these textbooks.

Text is generally introduced to students through class reading and discussion. The students then attempt questions based on the text. However, the most recent use of the Nuffield Co-ordinated Sciences Biology textbook with the students interviewed had been through comprehension type activities without prior class reading and discussion. One teacher interviewed suggested that the students did not like using the Nuffield Co-ordinated Sciences Biology textbook. Students are consulted on the selection of books for the library in this school but not on the selection of those for classroom use.

The Department offers the students of the year group which includes those interviewed (1996/97 Year 11), a choice between the Nuffield Double and Triple Award Sciences courses. In each half of this year group one set follows the Nuffield Triple Award Sciences course and the other five sets follow the Nuffield Double Award Sciences course. (NCS Newsletter 7, May 1994, includes an article by Elaine Brown of the OU [Brown 1994] about the implementation of the Triple Award course syllabus in this school. One aspect of this was the issuing of all the course textbooks to each of the triple award students for the duration of Key Stage Four.) Students are setted on the criterion of ability in Science as determined by test results and teacher recommendations. There is some flexibility in the system for movement between double award sets but this is limited by the science subject lesson rotation system. The top three sets in each half year are given specialist teaching. In the lower three sets in each half year the amount of specialist teaching depends on the expertise of the staff available. Some top Key Stage Four sets are made large (34 students) so that bottom sets can be made smaller (about 20 students). The sets are organised in this way in order that students in the lower sets may be given more individual attention.

Students are taught the science subjects separately within a lesson rotation system. There are five 70 minute lessons of Science within each six day timetable cycle in Year 10 and four in Year 11. This represents 19%of the curriculum time available in Key Stage Four. Students study all three sciences at any one time. However, in rotation, they have only one lesson a week of one or two them. The Department have tried out various science subject lesson rotation systems in recent years. The year group studied (1996/97 Year 11) was the last cohort of students to follow the

Nuffield Co-ordinated Sciences course in this school. The following year group follow the NEAB Modular Science course.

The teacher responsible for Biology in this school has grave reservations about the Nuffield Co-ordinated Sciences Biology textbook. The Department have not used it for most topics for the past three years. However, they do use the sections on Genetics, Growth and Farming. When they use these textbooks with students they use them for series of lessons in order to provide the students with a sense of continuity. They use the Nuffield Co-ordinated Sciences Biology textbooks for the questions, not for class reading. The sections used are quite well structured and the questions in them are better than those in the rest of the textbook because they are shorter and more specific. Generally speaking, the teacher concerned felt that the questions in this textbook draw too much on Students' knowledge of other areas of the textbook, the companion textbooks and activities sheets. These companion textbooks were not always readily available to students in biology classrooms in this school. The Nuffield Co-ordinated Sciences Biology textbook assumes that students do a lot of learning on their own. She also commented that "*All the good practical work is at the beginning of the textbook and all the reading and non-practical work is at the end. Lower ability and mid range students find the text uninteresting and in some cases, too demanding*".

Appendix B: Transcripts

Contents

Appendix B

Transcript Number 10111

Date of recording 16.03.94

At School Number 1011

Description of material A classroom interaction about an OHP on the lungs and thorax.

Participants A Teacher, Mrs. S and her class of bright students.

It was not possible to time pauses because the discourse was collected using a voice activated tape recorder.

The book referred to in this transcript is not the Nuffield Co-ordinated Science Biology textbook.

Mrs S. Right! Folks! (Speaking about the OHP) That's a little bit on the pale side with my apologies. But ..... Sorry.... Errrr... Yes that'll do....

But. It's a little bit on the pale side.... But . ... (Indistinct teaching discourse with student about the task). Go on then....

Now. I'mmmm hoping. I've said this before. I'm hoping that this will ring a bit of a bell with Year Nine work. But also, do you remember, that I, that I actually asked you to do an exercise on a sheet with words missing, twenty five words missing, wouldn't let you copy it out, wouldn't let you keep it. Yes.... ????

Students YES

Mrs S. Yes.. Right! So we have in fact, covered this. But some of you don't look very comfy. Because, this week's homework's going to be a bit heavy if you don't get this straight. Next week, if you thought today was a little bit hairy, giving presentations on gas exchange in four animals, it's nothing to what we're gonna do next week. Or rather, what you're going to do. Now. (Pause) Let's try and (Pause) put it all together. Alright!!

025	(Sounds of movement)
	Okay..... Where are those?
Students	Behind the ribs.
Mrs S. 029	Behind the ribs. Alright. We get 'em behind the ribs. Where are the ribs?
Students	(Indistinct discussion) There.........
Mrs S	Peter goes like so. Is that it?
Students	(Severally) Yea.....
Mrs S.	Them there.......
Students	(Severally) Yea....
Mrs S	Everybody's got ribs here?
Students	(Severally) There.....
Mrs S.	Is that where you've got your ribs?
Students	(Discussion) There.....
Mrs S.	Yer what??????
040	Oh..... All the way round! Thank goodness for that. Right. They're all the way round! Are you not aware of the fact that they are ALL THE WAY ROUND.
Students	(Severally) YER
Mrs S.	Right.... Excellent.
046	(Pause)
	Erm...... What part of the body are your lungs in? What d'yer call this?
Students	Chest.
Mrs S.	Chest! Posh word? (Claps hands)

Students	{Thor........Thorax
	{
052	{Pardon?
Mrs S.	Thorax..... right. Lungs just about fill the
	thorax. But there's one other very important organ
055	in there.
Students	(Severally) Heart.
Mrs S.	Heart! Right! OK! Brilliant.
	Now, how does, (Pause) the air, actually reach the
059	lungs?
Student	Through yer air passages.
Mrs S.	Ah.... Yes.....
Student	Nostrils.
Mrs S.	Well.... um.....
Student	Through yer mouth.
Another S	Yea.
Mrs S.	I don't know what yer doing there. Let's just have the route first of all, let's just have the route.
068	(Pause)
Student	Mouth.
070	What????
Student	Mouth.
Mrs S.	Mouth?
	Listen..... Frogs do their thing... We do our
074	thing... It's not the same. Now, through where?
Student	Through yer mouth....
Mrs S.	Oh.........?

Students {Nose.... nose.
{
{Nostrils
{
{Through the nose.

Mrs S. No.. Why am I? Will you be quiet now, just a minute, just a minute. With this breathing through the mouth job. Right, (Pause) there's a very important reason for this. Your noses are designed for breathing the air for reaching your lungs which are very very delicate. Now John... Right, now let's consider why the nose is there.
Go.....

Student To clean the air.

Mrs S. Right... To clean the air. What is?... What's inside the nose to help to clean it.

Student Cilia, like little hairs.

Mrs S. Little hairs.... Yes.... I wouldn't call them cilia cos they're too big. But, Yer hairs. AND lots of....
MMM ....

All Mucous!

Mrs S. Mucous...

(Pause)

It's called mucous!

(Laughter)

Right! Now, some of you.... when we did this with 10AR yesterday. Two ladies who I won't name who were sitting over here, sort of turned their heads away, in quiet disgust they were, and you could see they were thinking (in an affected accent) Oh no not in my nose!!! Not hairs and mucous! Oh yes you have, right. You have also got, please think about this carefully, you've got quite a lot of, of blood coming near the surface there. Nose bleeds, most people have had. And you've got a very interesting,

a very interesting surface, nooks and crannies and
crevices and all sorts of things. And you know
about it, cos I said this to 10AR yesterday when we
were talking about it. That don't tell me that you
115 haven't at some point in your life even if you were
only four and a half, five then. And yer know what
I'm goinga say, don't you. You've stuck yer finger
up yer nose and had a good ferret round.

Students Er (Giggling)

Mrs S. You can't actually, can you? You can't, (Pause) go
round like so. There's things in the way, aren't
122 there. Right.

Student (Indistinct)

Mrs S. (Laughs) All these nooks and crannies that makes the
air go round and it gets warmed up and it gets
126 moistened and it's cleaned and all that before it
goes down to your lungs. Now Peter, if you were to
think for a minute about what happens if you breathe
through yer mouth. And everybody else. You breathe
130 through yer mouth (Breathes) you take in a big, sort
of chunk of air. Alright, nothing to clean it, if
you like moistness and blood around the outside will
actually wet and warm a bit of it. And the rest of
it will go down cold and dirty, Wallop. Straight on
135 to the lungs, No. You've got any sense, No. Your
noses are built in free of charge folks, use them.
If you've got cold and you have serious problems
and blockage alright, aren't we grateful the mouth
will do. But really, don't talk to me about
140 breathing in through yer mouth. It's bad news. It
does yer lungs no good whatsoever. Agreed? Right.
Now, having got the air in there, where do we go to
next?

Students {There........
{
145 {(Indistinct)

Mrs S. Now, come on, come on. You've got information
there, you've got information there. You can think
146 about it. Now put it all together.

Student Trachea.

Mrs S. Trachea. Right. Posh name for?

Student Windpipe.

Mrs S. Right. Er... Before we actually get into the trachea we pass through the.....

Students {(Indistinct)
{
155 {Voice box

Mrs S. Voice box. Posh word?

Students {(Severally) Larynx.
{
Mrs S. {...................Larynx Right. Pronounced in the gentlemen rather and known as the......

Students Adam's Apple........

Mrs S. ..... Adam's Apple. And everybody can actually feel. You....... Just put your fingers on there. Arrrrr, any noise you like. Can you feel
164 vibrations, yer vocal cords? Arrrrrr?????

Students (Enthusiastically) Arrrrrr........ (Controlled mayhem).

Mrs S. (Amid mayhem) Breakthrough? Feel free........ That's it. Right. Excellent. Now then , from the trachea. (Pause) Sonya's enjoying this.

170 (Aside) Sonya, it's the first time I've seen you smile today, excellent.

Students (Laughter)

Mrs S. Now. From the trachea you've got to arrive (Pause) to both lungs, you've got to get some air to both
175 lungs. So the trachea has to split, into two main branches. What's each main branch called? Nicky?

Student Bronchus.

Mrs S. A bronchus tube. Right. And then the bronchus tubes split and split and split and split and branch
181 and branch and branch and.... call it what you will

	and you like. But what do we call the various.......
Students	(Indistinct)
Mrs S.	Bronchioles. Excellent. And the bronchioles end up in ....
Students	(Severally) Alveoli.
Mrs S.	Alveoli. Right. Air spaces that look like, some people think of them as little bunches of grapes stuck on the end. Right. Shapewise anyway. Now, if you turn over here and have a look at page 190 figure five, (slowly) **page 190 figure five**, right, you see there a photograph (Pause) describing? ..... It's showing you what? described as a? What's it say?
Students	Corrosion..........
Mrs S.	Corrosion preparation. Right. What does the word "corrosion" mean? or "corrosive".
Student	Burnt away.
Mrs S.	Burnt away, Yes, Right. Now I want you to imagine what's been done here. I mean, it says, worrying really, "human lungs", right. If you take a pair of human lungs, dead human lungs, I would imagine. And push down, through the trachea, some liquid material in the first place, pushed and forced and pumped it, and heavens knows what. Until it's gone all the way to all the air passages, absolutely filled the air passages. And then it's been allowed to set into something, that for the sake of argument is vaguely, rubbery. Alright, just for the sake of argument, something like latex, Right. And, the lungs have been put, and going to get, into that stage, as it were, in something like a big, big vat of acid, say. Which has eaten way all the, lung tissue, and it's left you with, that stuff that's set in all the air passages, d'yer get it? Right.
Student	(Indistinct)

Mrs S. But, Yea

JK Yea, yea.

Mrs S. But, you can't see alveoli, you've got to be reasonable. The ends of the bronchioles are so fine. And the alveoli are really minute. That you haven't got those details. You've got to be, you know, little bit realistic about this. But it doesn't matter. I think this is really quite, brilliant. And in some textbooks it's called a "bronchiole... per'aps you might know it, it's called a "bronchiole tree".
Let's go (Pause) back to this for a minute. (Pause) Erm.... I wonder if yer going to remember any of this. Look here at these, what they're like squiggly lines, as though Mrs S. just wanted to do a little bit of airy fairy shading. No I didn't.

Student (Quietly) Yea

Mrs S. Those lines represent something. And on that, (Pause) sheet that you did, I think it was a fortnight ago, wasn't it? It actually referred to....... It said, yes.... If you look at your twenty five words, see if you can get any clues. It said "The trachea is supported by......."

(Long pause)

Not.... You'll......
We did that in the back of your book if you remember. You were told to do it in the back. Anybody got any....... any clues on.......?

Student (Indistinct)

Mrs S. (Claps hands) Excellent, Right. Cartilage. Pieces of cartilage which, which, are sometimes described as rings but they are not rings, cos that's as a circle. They are "C" shaped. Have a look at the top diagram on page 190 please, top diagram, page 190, now I don't how..... what shall I say? I don't know how that diagram is to you. I have to look at it twice. It says on it "Front of neck, Back of neck". Just look at it carefully and try to picture the situation. Right, so it's some at here. And what you've got is, the trachea in front of the oesophagus. Remember the oesophagus. They've just put "gullet", "gullet". Right, now. What on that diagram represents the pieces of gristle (Pause), cartilage?

Student — Them bits. The white bits.

Mrs S. — The white bits, right. You can see the white bits. And can you see... D'yer agree with what I'm trying to get over here. They are **not** complete rings. See what I'm getting at. They are **not** complete rings. They are "C" shaped, "letter C" shapes. Right, leaves a gap at the back, so that the oesophagus fits against that gap, and when you're trying to swallow food and the oesophagus is, sort of, literally forced open and squeezes back, forced open and squeezes back. What's the posh word for it. (Claps hands) Begins with P. Peri.....

Students — (Severally) Peristalsis.

Mrs S. — Excellent right, peristalsis, wonderful. Now, is actually physically possible. If they were complete rings, imagine what swallowing would be like, horrendous. Trying to get past every cartilage ring, bump, bang, bump, bang all the way down. No, I couldn't imagine it at all, most uncomfortable.

Appendix B

Extracts from Transcript Number 10201

Date of recording 24.06.93

At School Number 1020

Description of material Discussion Task

Participants

Student Number 013 is called Fatima on the transcript.

Student Number 015 is called Tina on the transcript.

Student Number 016 is called Shailen on the transcript.

Student Number 022 is called Michelle on the transcript.

The students' names have been changed within this transcript in order to preserve their anonymity. Their responses to the questionnaire used with the cloze task are presented below.

Appendix B

N C S Research Project Responses Booklet

School Number 1020

Class Number CS3

Date 17.06.93

Student Number 013

Age 15 yrs 8 mnths

Male/Female Female

Do you like using the Nuffield Co-ordinated Sciences Biology Book?

Yes, most of the time

Why do you think like that about it?

The book is quite helpful when I'm doing my Biology homework or understanding the topic we have done

Which sections helped you a lot?

Photosynthesis

Which sections were difficult?

Breathing and Transport.

What would make the book better?

Glossary

Which languages do you speak at school? English

Which languages do you speak at home? Arabic + English

Which type of book do you usually use? Light blue cover

How often do you use the book? At least once a week

How do you usually use the book? Answering questions

When do you usually use the book? Equal amounts in class and at home

Appendix B

N C S Research Project Responses Booklet

School Number 1020

Student Number 015

Class Number CS3

Age 15 yrs 9 mnths

Date 17.06.93

Male/Female Female

Do you like using the Nuffield Co-ordinated Sciences Biology Book?

I do like using it, because it helps me with my work.

Why do you think like that about it?

As above

Which sections helped you a lot?

The section on the heart, blood and blood vessels.

Which sections were difficult?

The section on photosynthesis.

What would make the book better?

More diagram's, more detail.

Which languages do you speak at school? English, French

Which languages do you speak at home? English

Which type of book do you usually use? Light blue cover

How often do you use the book? At least once every few weeks

How do you usually use the book? Background reading, Answering questions, Making notes and Copying diagrams

When do you usually use the book? At home

Appendix B

N C S Research Project Responses Booklet

School Number 1020

Student Number 016

Class Number CS3

Age 15 Years

Date 17.06.93

Male/Female Female

Do you like using the Nuffield Co-ordinated Sciences Biology Book?

Most of the time.

Why do you think like that about it?

The book usually helps me with homework or understanding a topic but I also find it quite difficult to understand in some sections.

Which sections helped you a lot?

Photosynthesis and the very first unit.

Which sections were difficult?

Breathing and transport around the organism.

What would make the book better?

Adding a glossary.

Which languages do you speak at school? English

Which languages do you speak at home? English & Gujarati

Which type of book do you usually use? Light blue cover

How often do you use the book? At least once a week

How do you usually use the book? Answering questions

When do you usually use the book? Equal amounts in class and at home

Appendix B

N C S Research Project Responses Booklet

School Number 1020 **Student Number** 022

Class Number CS3 **Age** 15 yrs 9 mnths

Date 17.06.93 **Male/Female** Female

Do you like using the Nuffield Co-ordinated Sciences Biology Book?

Yes I do like using them.

Why do you think like that about it?

because they help me with /understand my work a lot more

Which sections helped you a lot?

The sections on the heart, blood and blood vessels

Which sections were difficult?

I haven't really found any yet, but the photosynthesis was not as easy as the others.

What would make the book better?

more diagrams etc.....

Which languages do you speak at school? English, French

Which languages do you speak at home? English

Which type of book do you usually use? Light blue cover

How often do you use the book? At least once every few weeks

How do you usually use the book? Background reading, Answering questions, Making notes and Copying diagrams

When do you usually use the book? In class and At home

Appendix B

N C S Research Project: Teachers' Questionnaire

School Number 1020 **Teacher's Name** Ms Flanagan

Class Number CS3 **Date** 24.06.93

Do you like using the Nuffield Co-ordinated Sciences Biology Book?

No

Why do you think like that about it?

I prefer a textbook with more factual recall questions and data response questions. Some of the diags are could be more diagrammatic so if need be could be copied but I like the colours in the book.

Which sections do you use most?

Passages of text to introduce a topic.

Which sections do you use the least?

I rarely use the questions, often too obscure. I rarely use the review sections although I feel I should.

What would make the book better?

As above, also change layout of the questions. I don't like them interspersed with the text.

Which edition of the book do you usually use? Light blue cover

How often do you use the book? At least once every few weeks

How do you usually use the book? Background reading

How do you introduce text to your classes when you use it? Reading aloud

When do you expect students to use the book? Homework

Appendix B

Transcript 10201A Fatima and Shailen

Extract A

S OK I' going to read it.

(Pause 25 seconds)

F They don't go into much detail, do they.

S It's just as well. I don't understand it.

F (Laughs)

(Pause 8 seconds)

F It's then. (giggling) Shailen, we'll talk about it anyway. Even if it bores us. (A few words not in English).

(Pause 24 seconds)

Extract B

S Uses of what then.

F Cos. Look, the woodland was used.... OK. Woodland and its uses. Cos Look, it was used to provide wood for poles and harvested.

S Woodland and use. Use of. What did you say? Anyway, there has to be some regrowth of a tree?

F Aswell? So OK..... erm Woodland and regrowth of trees.

S Yea

F {Woodland and regrowth of trees.

S {(reading the next section) This meant that...... patchwork material. Of these areas where pollarding had been done at different times, with each patch having a slightly different community.

S It's about the forest being a patchwork of pollarding............

F This meant that the forest consisted of a patchwork of areas where pollarding had been done at different times, with each patch of area having a slightly different community.

S Don't get that it's too small.

F Patchwork of areas..... Shall I pollarding. MMMMM Pollarding at different times,

S Yea

F or just pollarding? Oh I'm sorry. You won't be able to see it. Its (A non English word). It's not me. I didn't mean it.

S Guess what I'm getting?

(Whispering) .. a chocolate cake at lunchtime. A shape.

F A shell with cream and chocolate.

S With cream and chocolate?

F Yea well she's gonna make two different......

S Pollarding at different times. I'm gonna put a dash in my patchwork so we're reading notes on patchwork. In a patch that had just been pollarded.......

F What?

(Whispering) Shailen.... My eye shadow is going all...... Oh shit, I put too much on.

(Louder) What number now? Four?

Extract C

S Again Animals. (Pause) Yea. (Pause 8 seconds, sound, of writing) Grazing animals.

F MMMMM?

S These three grazing animals all help to keep some areas w……

F Yea but there also a herd of deers, rabbits.

S Where does it say that?

F Where?

S Where does it say that? Deers, rabbits.

F There's not a herd of fallow deer roaming the forest ?

S Yea, Then it's got that sentence then it says, "These grazing animals".

F OK. Graz…. grazing animals.

S Yes

(Pause)

Extract D

Heather and the adder (both girls giggle) are both organisms that must have... that must have unshaded habitants... habitats.

S So that's.

F Unshaded habitats.

S Yea...... Organisms have unshaded habitats.

F Who cares they don't say that. That's the main thing in this thing.

S No it's not the heather and the adder. We're talking about trees for there.

F OK, we can put heather and we can put adder. Huh....

S OK Well then

Extract E

JK How does this compare with the order that's in the book? Is it? It makes more sense in this order, do you think?

F {Yea
{
{Yea

S I mean it's in the book it jumps from the animals to the forest again and then to other animals and...

JK All right. Yea. So you reckon you've absolutely cracked it now. Have you?

S Yea

F Well

JK I mean... I'm just asking the question. I don't know that there's a .... I don't think that there's a sort of "right answer" to this. I'm just interested to see because you're going ... you see you go two, two, four, one and then twelve, well that's a picture isn't it, Number Twelve. Yea, it's fascinating.

F Well, I mean, if it was like this in the book we'd understand it more. And everything...... (Both laugh)

S It doesn't jump like for making notes from it you can just do one section at a time. I mean......

JK Right, yea, OK then. Well carry on, carry on. I mean you're, I'm bearing all. I'm listening to what you're saying. Erm.. You know, I can... This is the kind of helpful information I'm trying to drag out of this research. That you think this would be more, a better way of putting the book... Because you, you're not jumped between different ideas.

F {Yes
{
S {Yes

JK You've made it a lot more logical.

F Cos the way in the book if we're looking for notes it's sposed... we looking all.......

S Turning backwards and forwards and....

JK Yea

F Whereas this way's better.

JK All right. I'll just see how the others are getting on. You carry on thinking about what you talk about and what's wrong with the book. See what you can think of anything else that you'd say that was wrong with the book.

F I've loads to write down about the book. (laughs) I've got loads to write down about the book.

S Well.... I thought that we....... never mind.

(Pause)

F What's wrong with the book? Um... They jump topics.

S It's not in a logical.... really. (Pause) It's not set out in a logical way. sections.

F (Writing this down) It's not set out in a logical way. They jump, they jump, from, from one topic to another, sections. They jump from one section to another. Number Two. They don't go in much detail, I mean, like that you haven't got........ maybe not. Erm (Pause 15 seconds). We've got half an hour left.

S Great.

(Pause)

Let's see

(Pause)

The pictures jump.

(Pause)

F The pictures.

S They do, some of them are on the wrong sheets. In some of them it refers to figure whatever, and it's on the next page.

F The pictures aren't in order.

S They're in order...

F Yea but they, then they jump

S The pictures, the pictures don't always follow the text.

(Pause 11 seconds)

F I bet they're having a good gossip inside.

S Huh

Appendix B

Transcript 10201B Tina and Michelle

Extract F

M mmmmmmmm

T I..........

(Pause 10 seconds)

T They're really contradicting themselves with this, aren't they?

(Pause)

M Mmmmm......

(Pause 6 seconds)

T Cos they're destroying the environment by cutting down all the trees. That they're..... saying that they... Wild flowers and plants can grow. Cos there's no..... no shade. No leaves to shade the ground.

M Yea. That makes more plants grow.

(Pause)

T Yea, but then plants can still grow when there's trees there.

M I know. That's what I'm saying.

(Pause)

T That's no excuse.

(Pause 8 seconds, sighs, sniffs and deep breaths)

M So basically.......

T They're trying to find excuses for it to sound better.

(Pause 22 seconds, sniffs and clears throat)

M Well, it's OK.

(Pause 13 seconds, sniffs)

Here you are.

T Ahuh. What did you write? Careful.

(Pause 17 seconds)

They're saying it's good for reptiles as well.

M Though that's when the trees aint there innit.

T Yea. Then in some....

M They could be dangerous. Like, erm, (Pause) snakes there........

And then the trees grow back, right.... Then the....

T Reptiles.

M Then they're destroying they're home, cos the reptiles are living there then n'they.

T But then they cut down there. Then they cut down. They cut 'em down there.

M Yea, after fifteen years.

T That's true. You think they're contradicting themselves here, anyway though don't you.

(Laughter)

I can feel your brain there, making a cry going, "Oh No".

JK Can you explain the contradiction?

T Well they're saying, that, if you cut. The way we see it, they're cutting down trees and destroying the environment.

JK Yah

T And every time they cut it down. They cut it down every fifteen years so they'll just grow back and then they cut them down again.

JK Yea

T Then they're saying that plants 'nd wild erm... (Pause) flowers can .... grow where there's no sha.... where there's shade... no shade. Sorry I'm getting confused. And erm, (Pause) but they can still grow when there is shade. They just don't grow... as fast.

JK Right

T And now they're saying that reptiles can grow but then if the trees grow back then they're killing the reptile's house. Well, environment house.

JK So when you come to do your map of the whole thing, you'll have to bear that in mind...

T Mmmmmmm

JK So that you fit that in, to the overall scheme of things.

(Sighs and deep breaths)

T Mmmmmm

All Right

(Pause 5 seconds)

Two fine

(Pause 9 seconds)

Perhaps, I wonder who I could go out with.

M (Clears throat)

(Pause 7 seconds)

T Are you going out with.......

M No, he gave me up........

T Did he? Hello! tape recorder.

(Both laugh)

(Pause 23 seconds)

So, they're all......

(Pause 7 seconds)

M They're good. (Pause) No but it is good how the trees got there. but it means......

T Cos the animals will eat them won't they......

M They can, they can roam free that way.

(Pause)

T Yea, but that's really silly.

M Well, out there........

T You see, they go, they go everywhere, though, don't they. (Pause) They're really contradicting themselves, it's really bugging me.

M Are you all right?

T Yea, "Contradicting", its another word for me.

(Both laugh)

I like that.

(Pause 11 seconds)

So what about all the little squirrels.

M They've got no homes.

(Pause)

T So.

(Pause 21 seconds)

M Animals can what?

T Roam free.

(Pause 5 seconds)

This is so funny I like doing this.

(Pause)

M OK

(Pause 10 seconds)

Extract G

M Sunshine Plain, an area of Epping Forest, keep....
Kept free of trees by grazing.

T So what, what's that supposed to mean?

M Well.....

T They've kept all that free. And what is "free".
It's a waste.

M Allright.

(Pause 10 seconds)

T Umhuh Ten, looks like a snake!

M Heather 'nd.... Heather and the adder are both
organisms that must..... have unshaded habitats.

T Well why don't they go somewhere else? Why they
cutting the trees down just for them?

(Pause)

M Yea.

(Pause)

T Trees are important.

(Pause 29 seconds)

Number Eleven, (Pause) right.

(Pause 11 seconds)

T Now they're saying that it's preserving the habitats and wildlife. (Pause) Increased...... Increased the variety of organisms. (Pause 6 seconds) Preserved habitats and wildlife. (Pause) I suppose,

(Pause 16 seconds)

Mmmmm.. Odd innit... Unless you want to add something?

M It's no different from what they says there innit.

(Pause 7 seconds)

T I don't know try another one.....

M (Reading) This tree was once pollarded.........

They set out with one... nice looking tree... And then when they get thingy they get loads of difference in branches. Huhuh.....

T Yea

M What they had was one nice big tree was there. They got this one ... tree with all those branches coming out...

T Then... they cut it them off anyway.

M And then they go and cut it off anyway.

T It's stupid

(Pause 14 seconds whispering)

M Is it?

T You find it funny when I get irritated don't you.

M Huh

Extract H

T Have you read it?

M Mmmmm

T Trees are more important than plants.

M (Pause)

Innit, cos trees provide more oxygen.

M Mmmmm

T They do it with the light.

M I bet, sooner or later they're gonna cut down all them trees. So there's more shade .... there's no more shade...

T Yea, then plants can grow.

M So it's much better. I was thinking about this one here. Number eleven, Yea. They're saying that.... erm... I don't know..... I don't know about you..... But I thought about...... all the grazers.

T Trees are more important. (Pause) You know. When they do cut them down plants can grow. But in the meantime trees are more important.

(Pause 24 seconds)

Transcript 10201C Fatima, Shailen, Tina and Michelle.

Extract I

S I don't really know.

M Go ahead.

S Eh..... Forest kept free by grazing.....

T That's contradicting it....

(Pause)

(Sighs)

M Do you want to look at Number Ten? This is about trees
and environment are more important.... Then it's
cutting down trees.

S It's got unshaded habitats and heather and the
adder.

T Huuuuh....... That's contradicting as well.

F Eleven?

M The less trees there are, the more wildlife there'll
be.

S Pollarding and grazing preserves habitats and
wildlife.

F YES

Appendix C: Text analysis data

Contents

Appendix C

Table 5.a: Reading levels of prose, captions and questions passages

Page Number	Text type	Syllables/ 100 words	Sentences/ 100 words	Reading level	Discarded data
2-4	captions	151.9	8.6	13	Discarded
2	prose	138.9	6.2	13	
34-35	questions	136.1	4.6	13	
34	prose	144.9	7.5	13	
35-39	captions	158.1	11.4	13	Discarded
41	prose	156.8	4.0	17	
42-46	captions	124.3	13.6	7	
42-45	questions	131.7	7.9	11	
42-43	prose	144.7	5.3	14	
61-65	captions	124.8	10.1	9	
61-64	questions	151.9	9.3	13	Discarded
61-62	prose	150.5	5.4	15	
65-71	captions	128.6	8.2	10	
70-71	questions	135.1	8.3	11	
71	prose	130.6	4.6	13	
104-111	captions	154.9	12.0	13	Discarded
108-110	questions	123.4	6.3	11	
115-119	captions	123.0	10.0	8	
118-119	questions	115.1	7.6	9	
118	prose	146.0	8.9	12	
130-137	captions	147.1	10.8	12	Discarded
130-132	questions	128.0	5.6	12	
131	prose	127.1	6.2	12	
148	questions	141.8	6.8	13	
144-149	captions	129.6	6.8	11	
149	prose	154.6	5.5	15	
149-154	captions	158.9	8.9	15	Discarded
150-154	questions	149.5	9.1	13	
156-158	captions	148.6	10.5	12	Discarded
156-159	questions	156.1	4.7	16	
156	prose	165.4	6.5	17	
180-181	captions	142.2	6.4	13	
180-181	questions	140.7	9.3	11	
180	prose	146.1	5.8	14	
194-195	captions	139.8	5.6	13	
194-195	questions	132.4	6.9	12	
194-195	prose	128.5	4.9	12	
216-217	captions	147.7	8.3	13	
216-218	questions	151.5	7.4	14	
216	prose	152.4	5.8	15	

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Page Number	Text type	Syllables/ 100 words	Sentences/ 100 words	Reading level	Discarded data
278-279	questions	135.3	5.9	12	
279	prose	151.3	4.3	16	
283-288	captions	150.5	10.3	12	Discarded
283-284	questions	153.4	7.6	14	
283	prose	148.5	8.1	13	
303-306	captions	144.0	10.0	12	
303-304	questions	134.9	10.4	10	
303	prose	138.5	7.3	12	
308-312	captions	176.5	12.7	19	Discarded
310-312	questions	132.4	8.6	10	
312	prose	160.3	3.3	19	Discarded

Table 5.b: Reading levels analysis of thirty randomly selected prose passages from the textbook studied

Page Number	Syllables/ 100 words	Sentences/ 100 words	Text category	Reading level
2	161.1	6.7	hypo/theory	16
12	133.7	5.3	con/principle	13
21	148.5	9.7	classification	12
25	165.2	8.0	classification	16
27	129.4	7.6	classification	11
59-60	162.4	3.7	mechanism	16
81	152.3	5.5	con/prin/mech	15
94	148.2	6.3	con/principle	14
103	150.0	4.9	con/principle	15
113	129.5	4.5	structure	13
148	140.2	6.3	process	13
153	140.0	7.4	structure/mech	12
165-166	152.4	5.7	process	15
178	149.1	5.4	con/principle	14
182-183	140.7	7.6	process	12
186	148.7	4.2	process	15
186	152.8	7.6	process	14
189	146.0	7.2	classification	13
205-206	140.2	4.1	con/principle	14
214-215	151.0	5.8	process	15
219	144.6	6.4	classification	13
249	142.0	4.5	process	14
253-254	146.4	4.5	structure	15
256	140.2	4.9	process	14
269	140.0	4.0	con/principle	14
272	143.1	4.6	struct/process	14
289	132.1	5.5	struct/class	12
290	154.3	5.2	struct/class	15
290	155.9	5.1	class/struct	16
306	157.1	6.7	process	15

(The text categories used here follow Davies and Green's [1984 pp. 89-132] taxonomy of the types of school science text, i.e. instructional, classification, structure, mechanism, process, concept principle and hypothesis theory.)

Table 5.c: Text analysis of questions, cloze task and code switch passages

Page Number	Links with the figures analysis (Tables 5.f-5.i)	Text type	Text category	Reading level	Code switch
34-35		questions	hypo/theory	13	
40-41		questions	process	14	
42-45	4.03, 4.08	questions	classification	11	
61-62	6.01	cloze task	classification	15	D
62		cloze task	classification	15	D
62		cloze task	classification	15	
70-71		questions	classification	11	
108-110	9.09, 9.10	questions	process	11	
118-119	10.14	questions	struct/mech	9	
120	10.16	questions	struct/mech	9	
130-132	11.11-14	questions	struct/mech	12	
138		prose	struct/mech	12	R
139	11.21	prose	structure	13	R
140		prose	anecdote	9	R
140		prose	struct/mech	14	R
148		questions	struct/mech	13	
150-154	12.09-12.12	questions	proc/mech	13	
151	12.10	cloze task	process	13	
152	12.11	cloze task	struct/mech	13	L
152	12.11	cloze task	struct/mech	12	L
152	12.11	cloze task	struct/mech	12	L
152	12.11	cloze task	struct/mech	12	L
152	12.11	cloze task	struct/mech	13	L
152	12.11	cloze task	struct/mech	13	L
152	12.11	cloze task	struct/mech	14	L
152	12.11	cloze task	struct/mech	15	L
152	12.11	cloze task	struct/mech	15	L
152	12.11	cloze task	struct/mech	12	L
152	12.11	cloze task	struct/mech	15	L
156-159	13.01 a & b	questions	classification	16	
180-181	15.05	questions	classification	11	
194-195	16.06	questions	struct/mech	12	
216-218	17.29	questions	classification	14	

(The text categories used here follow Davies and Green's [1984 pp. 89-132] taxonomy of the types of school science text, i.e. instructional, classification, structure, mechanism, process, concept principle and hypothesis/theory. D = discourse switch, L = lexis switch, R = register switch)

Appendix C

Page Number	Links with the figures analysis (Tables 5.f-5.i)	Text type	Text category	Reading level	Code switch
225		cloze task	process	15	D
225		cloze task	process	14	D
226		cloze task	process	13	
278-279		questions	process	12	
283-284	22.02	questions	classification	14	
303-304		questions	classification	10	
310-312		questions	classification	10	

(The text categories used here follow Davies and Green's [1984 pp. 89-132] taxonomy of the types of school science text, i.e. instructional, classification, structure, mechanism, process, concept principle and hypothesis theory. D = discourse switch, L = lexis switch, R = register switch)

Appendix C

Table 5.d: Text analysis of essential health education texts

Page Number	Links with the figures analysis (Tables 5.f-5.i)	Text type	Text category	Health education issues	Reading level
47	4.12	prose	instructional	dental hygeine	12
47	4.12	prose	instructional	dental hygeine	13
61-64	6.01, 6.03-04	questions	classification	food & diet	13
61-62	6.01	prose	classification	food & diet	15
62		prose	classification	food & diet	15
62		prose	classification	food & diet	15
65	6.03, 6.04	prose	con/principle	obesity	14
70-71		questions	classification	food & diet	11
71		prose	classification	food & diet	13
73	6.14	prose	classification	food & diet	16
83	7.15	prose	pro/con/prin	smoking	17
94		prose	con/prin	b. transfusions	14
121		prose	struct/mech	sports injuries	17
138		prose	struct/mech	concussion	12
142	11.24	prose	proc/mech	alcohol	16
249	20.01	prose	process	sex education	14
251	20.01	prose	process	sex education	13
252		prose	process	sex education	15
253-254	20.07, 20.08	prose	structure	sex education	15
256		prose	process	sex education	14
262-263	20.16	prose	struct/mech	sex education	15
266		prose	classification	sex education	18
267		prose	process	sex education	22
277	21.14	prose	process	family life	13
278-279		questions	process	family life	12
279	21.16	prose	process	family life	16
285	22.05	prose	process	family life	16
296		prose	classification	family life	15

(The text categories used here follow Davies and Green's [1984 pp. 89-132] taxonomy of the types of school science text, i.e. instructional, classification, structure, mechanism, process, concept principle and hypothesis/theory.)

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Table 5.e: Text analysis of essential organisational texts

Page Number	Links with the figures analysis (Tables 5.f-5.i)	Text type	Text category	Function	Reading level
2		prose	Hypo/theory	introduction	16
2	5, 7	prose	Hypo/theory	introduction	13
5		prose	instructional	study skills	12
17		prose	classification	review	17
34-35		questions	Hypo/theory	task identification	13
40-41		questions	process	task identification	14
41		prose	process	review	17
42-45	4.03, 4.08	questions	classification	task identification	11
50		prose	classification	review	12
61-64	6.01, 6.03-4	questions	classification	task identification	13
70-71		questions	classification	task identification	11
73	6.14	prose	classification	review	16
101		prose	struct/mech	review	16
108-110	9.09, 9.10	questions	process	task identification	11
118-119	10.14	questions	struct/mech	task identification	9
120	10.16	questions	struct/mech	task identification	9
130-132	11.11-14	questions	struct/mech	task identification	12
148		questions	struct/mech	task identification	13
150-154	12.9-12	questions	proc/mech	task identification	13
154		prose	process	review	17
156-159	13.01 a & b	questions	classification	task identification	16
180-181	15.05	questions	classification	task identification	11
194-195	16.06	questions	struct/mech	task identification	12
216-218	17.29	questions	classification	task identification	14
248		prose	proc/class	review	14
267		prose	process	review	22
278-279		questions	process	task identification	12
283-284	22.02	questions	class/proc	task identification	14
303-304		questions	classification	task identification	10
310-312		questions	classification	task identification	10

(The text categories used here follow Davies and Green's [1984 pp. 89-132] taxonomy of the types of school science text, i.e. instructional, classification, structure, mechanism, process, concept/principle and hypothesis/theory.)

Appendix C

Table 5.f: The people depicted in images in the textbook studied

Figure number	Page number	Number of white people depicted	Number of non-white people depicted	Number of people depicted who could be either white or non-white
1	1	F		
2	1	M		
3	1		M (Asian)	
4	1	F		
5	2	M		
7	3	M2		
	7	F3 M3	F1 M1 (Af & As)	
1.01	8	M3		
1.11	15	P		
2.03	20	M2		
2.07	22	P		
4.03	44	P		
4.08	45			P
4.12	47	P		
4.13	48			P
5.01	50	M		
5.02	52			P
5.11	60			P
6.03	64	M		
6.04	64	F		
6.06	67	P		
6.07	68		P (Afr)	
6.14	74	M		
7.01	75	M P2		
7.02a	76	F		
7.02b	76	M5		P
7.04	76			F
7.05	77			P
7.06	78			P
7.15	83	M		
8.01	86	M		
8.17	97	P		
8.20	99			P
9.01	102			P
9.09	108	M		
9.10	108	M		

(M= male, F= female, P= person)

Appendix C

Figure number	Page number	Number of white people depicted	Number of non-white people depicted	Number of people depicted who could be either white or non-white
10.01	112	M20		
10.14	118	F M		
10.18	122			P
11.06	128			P
11.11	131	P		
11.12	131	P		
11.13	132			M2
11.14	132			P
11.16	134			P
11.17	135			P
11.18	135	P		
11.21	139			P
11.24	143	M		
12.01	144	M P		
12.03	147			P
12.09	150	F		
12.10	151	P		
12.11	152			P
12.12	153			P
	155	F M2 P		
13.01a	156		P12 (Afr)	
13.01b	156	P5		
14.01	167	M		
14.02	167	M		
14.07	172	M		
15.05	181	M		
16.06	195	M		
17.05	209		P>40 (Afr)	
17.29	218	F2		
18.12	223	P>100		
18.13	224			P<20
18.15	224			P>100
18.24	228	M4		P3
20.01	250	F3 M3		
20.07	254			F M
20.08	254			F M
20.09	256			F M

(M= male, F= female, P= person)

Appendix C

Figure number	Page number	Number of white people depicted	Number of non-white people depicted	Number of people depicted who could be either white or non-white
20.11	258	P		F
20.12	259	F P		
20.13	259	M		
20.14	260	F4 P5		
20.16	263			F
20.17	264			F M
20.18	265	F2 M2		
21.04	270			M5
21.08	271	P		
21.12	275			P2
21.14	277	F2 P		
21.15	278	F3		
21.16	279	M		
21.17	280	F2		
22.02	283	P4		
22.05	285	F2 M		
22.06	285	P5		
22.10	287	P2		
22.16	291	M		
22.22	293	F		
22.23	293	F M2		
22.24	294		P7 (Afr)	
22.27	297	M		
23.01	298			P3
23.04	300	M		
23.05	301	M		
23.08	303	P>100		
23.13	305		F (Asian)	
23.27	312	F M		

(M= male, F= female, P= person

Appendix C

Table 5.g The purposes of images in the textbook studied

Figure number	Page number	Instruction	Exposition	Creating context	Illustration
1	1				yes
2	1				yes
3	1				yes
4	1				yes
5	2				yes
7	3				yes
	7			yes	
1.01	8			European	yes
1.11	15			yes	yes
2.03	20			European	yes
2.07	22		yes		
4.03	44		yes	for some	
4.08	45		yes	yes	yes
4.12	47	yes		yes	
4.13	48		yes	yes	yes
5.01	50			yes	yes
5.02	52		yes	yes	yes
5.11	60		yes	yes	yes
6.03	64				yes
6.04	64	yes		yes	yes
6.06	67			yes	yes
6.07	68		yes		yes
6.14	74		yes	yes	yes
7.01	75			yes	yes
7.02a	76		yes	yes	yes
7.02b	76		yes	yes	yes
7.04	76	yes			yes
7.05	77		yes	yes	yes
7.06	78		yes	yes	yes
7.15	83		yes	yes	yes
8.01	86			yes	yes
8.17	97	yes		yes	yes
8.20	99		yes	yes	yes
9.01	102				yes
9.09	108			yes	yes
9.10	108			yes	yes
10.01	112			for some	yes
10.14	118			yes	yes
10.18	122			yes	yes

Figure number	Page number	Instruction	Exposition	Creating context	Illustration
11.06	128		yes	yes	yes
11.11	131		yes	yes	yes
11.12	131		yes	yes	yes
11.13	132		yes	for some	yes
11.14	132		yes	yes	yes
11.16	134		yes	yes	yes
11.17	135		yes	yes	yes
11.18	135		yes	yes	yes
11.21	139		yes	yes	yes
11.24	143		yes	yes	yes
12.01	144			yes	yes
12.03	147			yes	yes
12.09	150		yes	yes	yes
12.10	151		yes	yes	yes
12.11	152		yes	yes	yes
12.12	153			yes	yes
	155			yes	yes
13.01a	156				yes
13.01b	156				yes
14.01	167			yes	yes
14.02	167		yes	yes	yes
14.07	172		yes	yes	yes
15.05	181				yes
16.06	195			yes	yes
17.05	209		yes		yes
17.29	218			yes	yes
18.12	223			yes	yes
18.13	224			yes	yes
18.15	224			yes	yes
18.24	228			yes	yes
20.01	250		yes	yes	yes
20.07	254		yes	yes	yes
20.08	254		yes	yes	yes
20.09	256		yes	yes	yes
20.11	258		yes	yes	yes
20.12	259				yes
20.13	259			yes	yes
20.14	260		yes	yes	yes
20.16	263		yes	yes	yes
20.17	264		yes	yes	yes
20.18	265			yes	yes

Figure number	Page number	Instruction	Exposition	Creating context	Illustration
21.04	270		yes	yes	yes
21.08	271			for some	yes
21.12	275		yes	yes	yes
21.14	277			yes	yes
21.15	278		yes	yes	yes
21.16	279			yes	yes
21.17	280		yes	yes	yes
22.02	283			yes	yes
22.05	285			yes	yes
22.06	285		yes	yes	yes
22.10	287		yes		yes
22.16	291				yes
22.22	293		yes	yes	yes
22.23	293		yes	yes	yes
22.24	294		yes		yes
22.27	297			yes	yes
23.01	298		yes		yes
23.04	300			yes	yes
23.05	301			yes	yes
23.08	303			yes	yes
23.13	305				yes
23.27	312			yes	yes

Table 5.h: Links figures and activities and questions, the style of presentation and the nature of images in the textbook studied

Figure number	Page number	Acts	Ques	Doing	Nature of image	Style of image
1	1			yes	positive	colour photo
2	1			yes	positive	colour photo
3	1			yes	positive	colour photo
4	1			yes	positive	colour photo
5	2			no	positive	mono photo
7	3			no	positive	mono photo
	7			no	neither	colour photo
1.01	8			yes	positive	line drawing
1.11	15	yes	yes	yes	positive	colour photo
2.03	20		yes	no	neither	colour photo
2.07	22		yes	no	neither	colour photo
4.03	44	yes	yes	no	neither	colour photo
4.08	45	yes	yes	no	neither	colour diagram
4.12	47	yes		yes	neither	colour diagram
4.13	48		yes	no	neither	colour diagram
5.01	50	yes		yes	neither	colour sketch
5.02	52		yes	no	neither	mono photo
5.11	60		yes	no	neither	mono photo
6.03	64			no	negative	mono photo
6.04	64	yes		yes	negative	colour diagram
6.06	67		yes	yes	positive	colour photo
6.07	68			no	negative	mono photo
6.14	74			yes	positive	colour sketch
7.01	75			yes	positive	colour sketch
7.02a	76		yes	yes	positive	colour photo
7.02b	76		yes	yes	positive	colour photo
7.04	76	yes	yes	yes	positive	colour diagram
7.05	77			no	neither	mono photo
7.06	78	yes	yes	no	neither	mono photo
7.15	83			yes	neither	mono photo
8.01	86			no	negative	mono photo
8.17	97	yes	yes	yes	neither	colour diagram
8.20	99			no	neither	colour diagram
9.01	102			yes	neither	mono photo
9.09	108		yes	yes	positive	colour photo
9.10	108		yes	yes	positive	colour photo

(Acts = linked activities, Ques = linked questions, Doing = are the people depicted doing anything?)

Appendix C

Figure number	Page number	Acts	Ques	Doing	Nature of image	Style of image
10.01	112			yes	positive	colour photo
10.14	118	yes		no	negative	colour sketch
10.18	122			no	neither	mono photo
11.06	128	yes	yes	no	neither	colour diagram
11.11	131	yes		no	neither	colour photo
11.12	131	yes		no	neither	colour photo
11.13	132	yes		yes	positive	line drawing
11.14	132		yes	no	neither	colour diagram
11.16	134	yes		no	neither	colour diagram
11.17	135			no	neither	colour diagram
11.18	135			yes	neither	colour diagram
11.21	139		yes	no	neither	mono photo
11.24	143			yes	negative	line drawing
12.01	144			yes	negative	colour sketch
12.03	147		yes		neither	colour photo
12.09	150		yes	yes	positive	colour photo
12.10	151		yes	no	neither	colour diagram
12.11	152			no	neither	colour diagram
12.12	153			no	neither	colour photo
	155			yes	positive	colour photo
13.01a	156		yes	no	negative	colour photo
13.01b	156		yes	yes	positive	colour photo
14.01	167		yes	no	neither	colour diagram
14.02	167		yes	no	positive	colour diagram
14.07	172			no	negative	colour diagram
15.05	181			yes	positive	colour photo
16.06	195	yes	yes	yes	positive	colour photo
17.05	209		yes	no	negative	colour photo
17.29	218		yes	no	neither	colour photo
18.12	223			yes	positive	colour photo
18.13	224			no	positive	colour photo
18.15	224			yes	positive	colour photo
18.24	228			yes	positive	colour photo
20.01	250			no	positive	colour diagram
20.07	254		yes	no	neither	colour diagram
20.08	254		yes	no	neither	colour diagram
20.09	256			yes	neither	colour diagram
20.11	258		yes	no	positive	colour diagram
20.12	259		yes	no	positive	colour photo pain

(Acts = linked activities, Ques = linked questions, Doing = are the people depicted doing anything? colour photo pain = colour photograph of a painting)

Figure number	Page number	Acts	Ques	Doing	Nature of image	Style of image
20.13	259			no	positive	colour photo
20.14	260			yes	positive	colour diagram
20.16	263			no	neither	colour diagram
20.17	264			no	neither	colour diagram
20.18	265			yes	positive	colour photo
21.04	270	yes	yes	no	neither	mono diagram
21.08	271			yes	positive	colour photo
21.12	275			no	neither	line drawing
21.14	277			no	positive	colour photo
21.15	278			no	positive	colour diagram
21.16	279			no	positive	mono photo
21.17	280		yes	yes	positive	colour diagram
22.02	283			no	positive	mono & col photos
22.05	285		yes	no	positive	mono photo
22.06	285			no	positive	colour diagram
22.10	287			yes	positive	colour diagram
22.16	291			no	positive	mono photo
22.22	293			no	negative	colour photo
22.23	293		yes	yes	positive	mono photo
22.24	294		yes	no	negative	colour photo
22.27	297			no	negative	mono photo
23.01	298			yes	negative	colour drawing
23.04	300			no	positive	colour photo pain
23.05	301			no	positive	mono photo
23.08	303		yes	no	positive	colour photo
23.13	305		yes	yes	negative	colour photo
23.27	312		yes	yes	positive	colour photo pain

(Acts = linked activities, Ques = linked questions, Doing = are the people depicted doing anything? colour photo pain – colour photograph of a painting)

Appendix C

Table 5.i: Changes to figures between the old and new editions of the textbook studied

Figure Number	Context Creation	Illustr-ation	Act & Ques	Doing	Image	Differences between old and new editions
5		yes		no	Pos	Monochrome to colour
6.07		yes		no	Neg	African to White child
9.09	yes	yes	Ques	yes	Pos	White to black athlete
11.11	yes	yes	Act	no	Nei	Fair to dark skin
	yes	yes		yes	Pos	White to Asian family
16.06	yes	yes	Act & Ques	yes	Pos	White to darker skin
18.24	yes	yes		yes	Pos	One non white person instead of none
20.16	yes	yes		no	Nei	Chinese birth control poster added to diagram
21.16	yes	yes		no	Pos	White grandad to black
22.02	yes	yes		no	Pos	White twins to black
22.05	yes	yes	Ques	no	Pos	White family to black
23.08	yes	yes	Ques	no	Pos	A photograph of a more multicultural crowd

(Act & Ques = associated activities and questions, Doing = are the people depicted doing anything?, Pos = positive, Neg = negative, Nei = neither)

Appendix C

Analysis of explanations for the words and phrases used in the extracts from the textbook studied used as a cloze task

Extract 1: diet

Word or Phrase	Not in Index	Explained elsewhere in book	Explained in extract	Explained using conventions
Diet	*			
Body	*			
Healthy	*			
Food	In index, reference to extract studied			
Raw materials	*			
Proteins		*	*	*
Fats		*	*	*
Carbohydrates		*	*	*
Ingredients	*		*	
Vitamins			*	*
Minerals	In index, ref to extract studied & other context			
Calcium	*			
Phosphorus	*			
Sodium	*			
Iron	*			
Roughage		*		
Vegetable fibre	*	*		
Balanced diet			*	*
Growth		*		
Replacement	*			
Repair	*			
Tissues	*			
Living cell	*			
Vitamin A	Vitamins is in the index. But Vitamins A, D, & E are not explained in the extract they are just mentioned.			
Vitamin D				
Vitamin E				
Starchy	as starch	*		
Sugary	*			
Energy		*		
Foods	*			
Animals	*			
Amino acids		*		
Function	*			
Essential amino acids	*	(see amino acids)	*	
Animal protein	*	(see protein)		
Vegetable protein	*	(see protein)		
Plants		*		

Extract 2: kidneys

Word or Phrase	Not in Index	Explained elsewhere in book	Explained in extract	Explained using conventions
Liquid	*			
Mechanism	*			
Intake	*			
Output	*		*	
Average resting adult	*			
Experiment	*			
Red blood cells		*		
Plasma		*		
Gut		*		
Blood		*		
Dilute	*			
Salty	*			
Viscous	*			
Control	*			
Organs	*			
Kidneys			*	
Regulate	*			
Filter	*			
Nephrons	*			
Ureters	*		*	
Bladder	*		*	
Urinate	*			
Excrete	*		*	*
Poisonous	*			
Substances	*			
Excretory	*			
Urea			*	*
Waste	*			
Breakdown	*			
Excess amino acids	*	(see amino acids)		
Liver	In index, not explained in text.			
Mineral salts	*	(see Minerals, different contexts)		
Body fluids	*			

Extract 3: conservation

Word or Phrase	Not in Index	Explained elsewhere in book	Explained in extract	Explained using conventions
Forest	*			
Deciduous	*			
Coniferous	as conifers	*		
Woodlands		*		
Populations		*		
Human populations				
Habitat		*		
Natural habitats	*			
Wildlife	*			
Preserve	*			
Conservation			*	*
Climax stage/ woodland	as climax communities	*		
Succession		*		
Harvest	*			
System	*			
Pollarding			*	*
Re-growth	*			
Growth		*		
Cycle	*			
Communities		*		

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Appendix D: Research instruments and procedures

Contents

- **Discussion Task**
    - Procedure for the administration of the discussion task
    - Kit list for the administration of the discussion task
    - Discussion and concept mapping task
    - Example of discussion task

- **Follow up Questionnaire and Interviews**
    - N C S Research Project: Follow Up Questionnaire
    - N C S Research Project: Follow up interviews with students

Appendix D

Procedure for the preliminary visit

Before the date

Write to Head of Dept and Headteacher, see letters.

Ring a week later asking times when target teacher can be contacted. Allow a lot of time for this.

Check kit

At the school

Explain project

Run through checklist

Get a copy of the classlist

See the target children if possible

Explain teacher questionnaire

Offer INSET and explain

Check that interviewees don't mind being taped

At home

Write up draft profile

Appendix D

Kit list for the preliminary visit

The School folder

Tape recorder

Tapes

Spare batteries

Diary

Copies of the instruments

Copies of the responses booklets

Copies of both editions of the books

Copies of both checklists

Copies of the protocol

Portfolio

Teacher questionnaires

Copy of the procedure

The schools directory

Appendix D

Procedure for the main research planning visit

Before the date

Write to Head of Dept, see letters.

Ring a week later asking times when target teacher can be contacted. Allow a lot of time for this.

Check kit

Read profile, highlight any problems with it

At the school

Explain project findings

Find out what they want from data

Fix dates

Get copies of classlists

See the target children if possible

Offer INSET and explain

Check that interviewees don't mind being taped

At home

Update profile

Write to school confirming dates and enclosing enough teacher questionnaires and updated profile

Appendix D

Kit list for the main research planning visit

The School folder

Tape recorder

Tapes

Spare batteries

Diary

Copies of the instruments

Copies of the responses booklets

Copies of both editions of the books

Copies of the protocol

Portfolio

Draft thesis

Data

Teacher questionnaires

Copy of the procedure

The schools directory

Appendix D

N C S Research Project: Teachers' Questionnaire

School Number................ Teacher's Name..............

Class Number................ Date........................

Do you like using the Nuffield Co-ordinated Sciences Biology Book?

....

Why do you think like that about it?

....

....

....

Which sections do you use most?

....

....

Which sections do you use the least?

....

....

What would make the book better?

....

....

Have you any other general comments to make about the book?

....

....

....

....

....

....

....

....

Please turn over

Appendix D

Please answer these questions by ticking the boxes.

There are two editions of the Nuffield Co-ordinated Sciences Biology book. The latest edition has a dark blue cover. The old edition has a light blue cover.

Which edition of the book do you usually use?

Dark blue cover :_: Light blue cover :_:

Both equal amounts :_:

How often do you use the book?

At least once a lesson :_: At least once a week :_:

At least once every few weeks :_: To cover absence :_:

Hardly ever :_:

How do you usually use the book?

Background reading :_: Answering questions :_:

Making notes :_: Copying diagrams :_:

In another way :_:

If you said "in another way", please describe what you do.

....

....

....

How do you introduce text to your classes when you use it?

I discuss it with them :_: Summarising activities :_:

We pick out key words :_: Note taking :_:

Reading aloud :_: Brainstorming :_:

None of these :_:

If you use any other techniques please describe them below.

....

....

When do you expect students to use the book?

Classwork :_: Homework :_:

Equal amounts classwork homework. :_:

Please turn over

Appendix D

The next section deals with the class's lessons during the four weeks leading up to the research task.

Please fill in a line of this grid for each lesson that the class did during that period.

Date and Time	Topics covered	Books used	How used	Comments

Please comment on the use of books other than the Nuffield Co-ordinated Sciences Biology book. Use the "How used" column to explain whether the book was used in class or at home and whether students were given any explanation of the text. Use the "Comment" column to explain any unusual circumstances such as teacher absence, sports days etc. It would also be useful to the research if you could indicate whether the lessons were all taught by the same teacher.

Thank you very much for your help with this research.

Appendix D

Procedure for students' questionnaire and cloze task administration

Before the date

Ring to confirm a few days before the activity

Read latest version of profile noting further questions

Make sure that you've sorted out the numbers and starting number. Each visit to a school should use a different set of numbers.

Check that the sheets in each pack are all there, are all facing the front, and are in the correct order.

At the school

Write on the board

Brief the teacher. They know the children, get them to give out the tasks.

Collect the teacher questionnaire

Offer the school profile for checking

Set out the materials

Use the protocol

Allow talking but not copying

Explain procedure in terms of "a fair test".

Pace the activity

Check the materials directly afterwards

At home

Update profile

Write up field notes

Appendix D

Kit list for students' questionnaire and cloze task administration

The school folder

Sufficient copies of the instrument

Taped instruments as appropriate

Sufficient copies of the responses booklet of all colours

Class list with numbers written on it

Board writer

Chalk

Tape recorder

Tape

Spare batteries

Copies of both edition of the book

Addresses folder

Task protocol or PRS protocol

Spare pens

Watch

Diary

Portfolio

Copy of the procedure

Copies of the teacher questionnaire

Copies of the school profile for correction

The schools directory

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NCS Research Project Responses Booklet

School Number ____________ Student Number ____________

Class Number ____________ Age ____________

Date ____________ Male/Female ____________

Do you like using the Nuffield Co-ordinated Sciences Biology book?

Why do you think like that about it?

Which sections helped you a lot?

Which sections were difficult?

What would make the book better?

Which languages do you speak at school?

Which languages do you speak at home?

Please turn over

Please answer these questions by ticking the boxes.

There are two types of Nuffield Co-ordinated Sciences Biology book. The covers are different. Some have a dark blue cover. Some have a light blue cover.

Which type of book do you usually use?

Dark blue cover ☐

Light blue cover ☐

Both equal amounts ☐

How often do you use the book?

At least once a lesson ☐

At least once a week ☐

At least once every few weeks ☐

Only when the teacher is away ☐

Hardly ever ☐

How do you usually use the book?

Background reading ☐

Answering questions ☐

Making notes ☐

Copying diagrams ☐

In another way ☐

If you said "in another way", please describe what you do.

____

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When do you usually use the book?

In class ☐

At home ☐

Equal amounts in class and at home ☐

Extract A: Section B12.4

Have you read this section before? ______________________

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Extract B: Section B18.2

Have you read this section before? ______________________________

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Extract C: Section B6.1 and B6.2

Have you read these sections before? ______________________

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Appendix D

Protocol for the administration of the students' questionnaire and cloze task

DO what is underlined SAY what is not.

<u>Hand out the booklets , face upwards.</u>

Please check that your responses booklet is the same colour as the card with your number on it.

At the top of the first page where it says "School Number" and "Class Number", write those numbers down. Write down the date, where it says "Date".

<u>This information will be clearly written on a board for students</u>

Next write down your student number from the card on your desk.

<u>These should be given out beforehand</u>

Write down your age in years and months, where it says "Age". And whether you're male or female in that space.

This is a test of this book to see how easy it is to read. It is not designed to test how much you know. There are a few questions for you to answer at the beginning so that we know a little bit about you. We gave you a number so that your answers will be totally anonymous.

First answer the questions about yourself and what you think of the book.

Look at the three extracts from the book on your desk. Each one has got words missing. The gaps are numbered. The sizes of the gaps should all be the same. They look bigger when they come at the end of a line. The size of a gap is not a clue about the length of the word deleted. The missing word could be a word like "a", or a word as long as "photosynthesis". The responses booklet contains three grids for you to write these missing words in. Each extract has got its own grid with the right number of spaces. The blue task starts with the extract on diet, the yellow with the extract on the kidneys and the pink with the extract on conservation.

First write down in the space at the top of each page whether you've read that page of the book before. Then write what you think is the missing word for each space in its numbered space on the right grid.

The extracts contain some easy words and some very difficult ones. Please try to fill in as much of the task as you can. You can take as long as you like.

Thank you for helping with this research.

Appendix D

Script for the audio cloze task introduction

Please check that your responses booklet is the same colour as the card with your number on it.

At the top of the first page where it says "School Number", write "1009" and where it says "Class Number", write the number of your Tutor Group. Write down the date, where it says "Date".

Next write down your student number from the card on your desk.

Write down your age in years and months, where it says "Age". And whether you're male or female in that space.

This is a test of this book to see how easy it is to understand. It is not designed to test how much you know. There are a few questions for you to answer at the beginning so that we know a little bit about you. We gave you a number so that your answers will be totally anonymous.

First answer the questions about yourself and what you think of the book.

This tape contains a recording of one of the three extracts from the book on your desk. Each extract has got words missing. The gaps are numbered. The sizes of the gaps should all be the same. They look bigger when they come at the end of a line. The size of a gap is not a clue about the length of the word deleted. The missing word could be a word like "a", or a word as long as "photosynthesis". The responses booklet contains three grids for you to write these missing words in. Each extract has got its own grid with the right number of spaces. The blue task starts with the extract on diet, the yellow with the extract on the kidneys and the pink with the extract on conservation.

The extract on this tape is the one about diet/ kidneys/ conservation.

First write down in the space at the top of the page whether you've read that page of the book before. Then write what you think is the missing word for each space in its numbered space on the right grid.

The extracts contain some easy words and some very difficult ones. Please try to fill in as much of the task as you can. You can take as long as you like.

Thank you for helping with this research.

Appendix D

Protocol for the students' questionnaire and audio cloze task administration

Please check that your responses booklet is the same colour as the card with your number on it.

At the top of the first page where it says "School Number", write "1009" and where it says "Class Number", write the number of your Tutor Group. Write down the date, where it says "Date".

Next write down your student number from the card on your desk.

Write down your age in years and months, where it says "Age". And whether you're male or female in that space.

This is a test of this book to see how easy it is to understand. It is not designed to test how much you know. There are a few questions for you to answer at the beginning so that we know a little bit about you. We gave you a number so that your answers will be totally anonymous.

First answer the questions about yourself and what you think of the book.

Each tape contains a recording of one of the three extracts from the book on your desk. Each extract has got words missing. The gaps are numbered. The sizes of the gaps should all be the same. They look bigger when they come at the end of a line. The size of a gap is not a clue about the length of the word deleted. The missing word could be a word like "a", or a word as long as "photosynthesis". The responses booklet contains three grids for you to write these missing words in. Each extract has got its own grid with the right number of spaces. The blue task starts with the extract on diet, the yellow with the extract on the kidneys and the pink with the extract on conservation.

First write down in the space at the top of the page whether you've read that page of the book before. Then write what you think is the missing word for each space in its numbered space on the right grid.

The extracts contain some easy words and some very difficult ones. Please try to fill in as much of the task as you can. You can take as long as you like.

Thank you for helping with this research.

Appendix D

Syllabus, Teacher's Guide and National Curriculum

Introduction

As explained in Chapter 5, the Nuffield Co-ordinated Sciences course predates the introduction of the National Curriculum for Science in 1989 [DESWO 1989] and its subsequent revision in 1991 [DESWO 1991b]. The book was written for a syllabus which is now obsolete and teachers are expected to adapt the materials to suit the new situation. Relevant extracts from the 1995 Syllabus [MEG 1993] are included in this Appendix. Sections 2.1 and 2.2 [p. 3] deal with the philosophy behind the course. Sections 3 and 4 [pp. 4-5] are a statement of Aims and Objectives. Section 5.1 [p. 6] is a statement of policy concerning language and literacy skills. Sections 6.4 and 6.5 [pp. 8-9] deal with differentiation and levels of entry. Under Section 10, Syllabus content, the general introduction [pp.23-25] and the sections pertaining to the three text extracts studied have been included in this compilation, section B.6 [p. 30], section B.12 [p.36] and section B.18 [p. 42].

A new Teacher's Guide [NCCT 1992b], supplementary activities and an Earth Science textbook [NCCT 1992c] have been produced to help teachers adapt the material to suit students' needs. Some of the material in the original textbooks is no longer required and some needs to be refocussed to satisfy the requirements of the National Curriculum. This Appendix also includes relevant extracts from these documents. The study schools were all using all of the material found in the extracts with all of their students who were familiar with it. The language used in these quotations from the National Curriculum and the use of programmes of study and statements of attainment in the classroom and in planning schemes of work is discussed in sections 3.2.5 and 3.2.6 of this thesis.

An examination of the parts of the programme of study for Key Stage Four (Double Science) dealt with, and the levels of the statements of attainment accessed, by each extract should give some insight into the aims and objectives of lessons involving them and the level of understanding required of students. The Key Stage Three programme of study should provide information on the prior knowledge expected of students at Key Stage Four.

Appendix D

Relevant syllabus extracts [MEG 1993a]

Section 2.1 p. 3

The concept of Co-ordinated Sciences

Nuffield Co-ordinated Sciences was originally designed and written as a Sciences: Double Award project in which pupils' reading , pupils' activities, teachers' guidance on teaching and planning, and the scheme for pupils' assessment would all be integral parts of a balanced science curriculum, in which each part would reflect and be dependent upon all the other parts. The Key Stage 4 syllabus for Science: Double Award and Science: Single Award continues this important principle. The unbreakable relationship between course and syllabus guarantees to teachers and pupils that what is taught and learnt is what is assessed.

The syllabus and the course set out a co-ordinated, systematically planned map of the concepts of science and the inter-relationships that link different areas of science. This is reflected in the fact that content is not set out Attainment Target by Attainment Target, but in a more coherent and holistic manner, frequently drawing together themes evident in several Attainment Targets.

The syllabus allows schools to retain, if they wish, the separate identities of Biology, Chemistry and Physics. At the same time it places each chapter of pupils' work in a broad context of real events or applications which necessitates cross-reference from one science to another and from science across the curriculum to other subjects.

Section 2.2 p. 3

Significance

The syllabus provides topics through which pupils can discuss issues which arise from the interaction of science with technology, economics, society and the environment. These serve to remind students that matters of science are also matters of the everyday world. At the same time, the science studied has immediate significance for pupils in terms of its intrinsic interest and its applications to their individual lives and preoccupations.

This emphasis on the application of science helps to make clear the importance of the cross-curricular themes identified in the National Curriculum. Studies of the issues and implications surrounding the large scale applications of scientific knowledge emphasise economic and industrial understanding, whilst extension of this to consider the tasks and responsibilities of those employed in such enterprises focuses attention on science-related careers.

Correlation between what is taught in the classroom and issues of world wide significance is a continual theme throughout Nuffield Co-ordinated Sciences.

This international significance is in accordance with the 1988 Resolutions of the European Community. More specifically, the syllabus strongly reflects the Resolutions on health education and environmental education. Topic B6 is entitled "Diet and Good Health", and several parts of the syllabus, including sections B17 and B18, deal with aspects of environmental education.

Sections 3 and 4 pp. 4-5

3 AIMS

3.1 The aims set out below describe the educational purposes of this GCSE syllabus for *Science: Double Award* and for *Science: Single Award* and are consistent with the National Curriculum Order for Science. Many of these aims are reflected in the Assessment Objectives and Schemes of Assessment; others cannot be readily assessed.

3.2 To provide through the exploration and study of science a coherent educational experience for all candidates which enables them to acquire sufficient understanding and knowledge to:

3.2.1 become confident citizens in a technological world, able to take or develop an informed interest in matters of scientific import;

3.2.2. recognise the usefulness, and limitations, of scientific methods and appreciate their applicability in other disciplines and in everyday life;

3.2.3. be encouraged to pursue and be suitably prepared for further studies in science;

3.2.4 recognise that the study of science is relevant to everyday life.

3.3 To develop abilities and skills that:

3.3.1 are relevant to the study, practice and application of science;

3.3.2 are useful in everyday life;

3.3.3 encourage safe practice.

3.4 To stimulate:

3.4.1 curiosity, interest and enjoyment in science and its methods of enquiry;

3.4.2 interest in, and care for, the environment.

3.5 To promote awareness that:

3.5.1 the study and practice of science are co-operative and cumulative activities and are subject to social, economic, technological, ethical and cultural influences and limitations;

3.5.2 the applications of science may be both beneficial and detrimental to the individual, the community and the environment;

3.5.3 the concepts of science are of a developing and sometimes transient nature.

4 ASSESSMENT OBJECTIVES

The Assessment Objectives describe the intellectual and practical skills which candidates should be able to demonstrate.

4.1 Objectives related to Sc1: Scientific Investigation

These Assessment Objectives lead to reporting under Sc1 and relate to the Statements of Attainment in Sc1.

Candidates should explore and investigate the world of science and develop a fuller understanding of scientific phenomena, the nature of theories and the procedures of scientific investigation. Their assessed activities should require a progressively more systematic and quantified approach which develops and draws upon an increasing knowledge and understanding of science. Candidates should be required to use the knowledge, skills and understanding specified by the syllabus to plan and carry out investigations in which they:

4.1.1 ask questions, predict and hypothesise;

4.1.2 observe, measure and manipulate variables;

4.1.3 interpret their results and evaluate scientific evidence.

4.2 Objectives related to Sc2, 3 and 4: Knowledge and Understanding of Science

These Assessment Objectives lead to reporting under Sc2, 3 and relate to the Statements of Attainment in these Attainment Targets.

4.2.1 Candidates should be able to demonstrate the knowledge, skills and understanding specified by the Statements of Attainment in Sc2, 3 and 4 of the National Curriculum for Science (relevant strands only for the Single Award).

4.2.2 communicate scientific observations, ideas and arguments effectively;

4.2.3 select and use reference materials and translate data from one form to another;

4.2.4 interpret, evaluate and make informed judgements from relevant facts, observations and phenomena;

4.2.5 solve qualitative and quantitative problems.

Section 5.1 p. 6

Language and literacy skills

Recording and storage of information in appropriate forms; using and understanding information gained from various sources; communication of ideas to others; summarising and organising information in order to communicate adequately; using appropriate language to explain the results of observations in a variety of contexts; using and interpreting scientific nomenclature, symbols and conventions.

Sections 6.4 and 6.5 pp. 8-9

Differentiation

The purpose of this differentiated Scheme of Assessment is to assess candidates, at levels at which they can demonstrate achievement and provide evidence of positive attainment, by using tiers of components designed to test particular parts of the ability range.

It follows that if candidates are to obtain benefit from taking papers designed to meet their particular needs, Centres must take care to ensure that each candidate is entered for the tier of papers for which he or she is most suited.

Advice on entry policy

Expectations of the performance of individual candidates may be based on a variety of evidence, including their performance at Key Stage 3 and their progress within Key Stage 4.

It is important that candidates are entered for a tier appropriate to their ability range, in which they will have the opportunity to demonstrate positive achievement on the relevant question papers.

Recommended tiers of entry,

For students expected to gain levels 4, 5 and 6; BASIC tier.

For students expected to gain levels 7, and 8; CENTRAL tier.

For students expected to gain levels 9, and 10; FURTHER tier.

Section 10 p. 23

Appendix D

This system of tiered entry was introduced at the 1995 examination.

Appendix D

SYLLABUS CONTENT

It is intended that this syllabus shall be as free as possible from sexual, racial, ethnic, religious or any other kinds of bias.

The content of this syllabus provides a means of delivering the Programme of Study for Sc2, 3 and 4 using an approach which develops knowledge and understanding of scientific principles through consideration of the applications and implications of science and scientific activities. Section 10 shows the syllabus content related to the programme of study and Statements of Attainment within Sc2, 3 and 4.

Teaching to this syllabus should involve candidates in activities that require a progressively more systematic and quantified approach which develops and draws upon an increasing knowledge and understanding of science. Candidates should be given the opportunities to develop further their skills of reporting and recording. They should be encouraged to articulate their own ideas and work independently or contribute to group tasks. They should develop research skills through selecting and using reference materials and through gathering and organising information from a number of sources and perspectives. They should have opportunities to translate information from one form to another to suit audience and purpose and to use databases and spreadsheets in their work.

Candidates should be encouraged to develop investigative skills both for their value in developing knowledge and understanding and as a basis for award of credit under Sc1 (see Section 7 of this syllabus).

The course of study followed by candidates for this syllabus should include activities which:

relate to their everyday experience and to new contexts, involving increasingly abstract concepts and the application and extension of scientific knowledge, understanding and skills, where pupils need to make decisions about the degree of precision and safe working required.

promote invention and creativity.

encourage detailed planning and evaluation in the light of findings.

are increasingly complex because they involve derived and/or interacting variables.

require key variables to be controlled or taken into account, and pupils to recognise that need.

require them to generate theoretical models and to test them.

may take place over a period of time and require sampling techniques.

require accurate measurement, with identification and quantification of, and accounting for, experiment error and anomalous results.

encourage the systematic recording and presentation of data using, as appropriate, a full range of forms, including graphs and mathematical relationships.

encourage pattern searching in complex data and predications requiring abstract reasoning.

involve the critical evaluation of data.

give opportunities to use information technology to gather and display data from experiments, to access and organise data relevant to their study of science, and to use programmable systems to control external electronic, electrical or mechanical devices.

explore the nature of scientific evidence and proof but in addition they should also:
distinguish between claims and arguments based on scientific considerations and those which are not.
distinguish between generalisation and predictive theories.
study examples of scientific controversies and the ways in which scientific ideas change.

encourage them to appraise critically their investigations including consideration of errors and suggest improvements to their models.

[...] If teachers wish to use the Nuffield Co-ordinated Sciences Pupils' books (published by Longman) in association with this syllabus, then it should be noted that each section of the Syllabus subject content relates to a specific chapter in the corresponding pupils' book.

[...] The shaded blocks to the left of the knowledge and understanding column indicate the relationship between the syllabus statements and the tiers of assessment.

B.6 Diet and Good Health

Context

This section allows ideas of healthy eating to be discussed in terms of the biological requirements of a balanced diet. Sensible eating patterns (including the dangers of excess sugar, salt, saturated fats and additives) should be discussed. The value of high-fibre foods and vegetarianism should be considered. Strategies for successful slimming can be developed in the light of the dangers of obesity and anorexia nervosa.

Tier B C F	Knowledge and Understanding	PoS	SoA
	Understand that a balanced diet contains sufficient energy to maintain life, and that the energy requirements of a person vary with age and activity.	2(i)1 2(i)5	2.5a
	Understand why fibre and vitamins are needed for health. Appreciate the unhealthy effects of eating too much fat and salt.	2(i)1 2(i)5	2.7a
	Know that the thyroid gland controls metabolic rate.	2(i)1 2(i)5	2.9a

Opportunities for Co-ordination

Proteins link to C3, salt to C5, carbohydrates to C8, food additives to C9. Food as an energy source or fuel is also in C13 and P12.

B.12 Homeostasis

Context

In this section, homeostasis is defined as the maintenance of constant internal conditions within organisms. The principles can be developed in a wide variety of contexts, including the maintenance of balanced water levels in the blood and fluid bathing the tissues, the regulation of body temperatures in mammals, and the maintenance of glucose. The practical implications of failure of the regulating mechanisms can be considered, (eg hypothermia, sugar diabetes, kidney failure), together with possible solutions.

Tier B C F	Knowledge and Understanding	PoS	SoA
	Be able to name and locate the principal systems which maintain constant internal conditions in animals and humans.	**2(i)1**	**2.4a, 2.5a**
	Be able to state and label the parts of human skin which are involved in regulating body temperature.	**2(i)4**	**2.5a**
	Appreciate how mammals and lizards regulate their body temperature (in simple terms).	**2(i)4**	**2.6b**
	Know and be able to explain that the kidneys remove excess water and waste products (eg urea) from blood plasma. Urine is produced and stored in the bladder. The composition of urine may be altered by the kidney tubules.	**2(i)4**	**2.8a**
	Appreciate that transplants and dialysis serve as possible solutions when a kidney fails.	**2(i)5**	**2.8a**
	Be able to explain the way in which the blood-sugar level in humans is co-ordinated through the hormonal control of insulin.	**2(i)2,4**	**2.9a**
	Understand the basic principles of genetic engineering in relation to insulin production.	**2(ii)5**	**2.9a**
	Understand and be able to explain how homeostatic and metabolic processes contribute to the control of human body temperature and breathing, including the role of negative feedback.	**2(i)4**	**2.10a**

Opportunities for Co-ordination

P20 deals with control systems, P2 with the kinetic theory of matter, P10 with energy change and temperature, C9 and C12 with dialysis.

B.18 Conservation of Habitats

Context

The conservation of natural habitats and endangered species requires an understanding of their ecology, and acts of preservation. This section considers these ideas by discussing a variety of different examples, some local and others of global significance. The biological, economic and political difficulties of conservation can be developed.

Tier B C F	Knowledge and Understanding	PoS	SoA
	Understand that changes in environment may cause extinction of a species and that it will have an effect on the remaining species in a community.	2(iii)3	2.5c
	Know that conservation of habitats requires active management by relating this to the environmental impact of human activity on the Earth.	2(iii)4	2.8d
	Understand the relationships between human activity on the Earth and size of population, economic factors and industrial requirements.	2(iii)4	2.8d

Opportunities for Co-ordination

The importance of chemical pesticides in modern agriculture is dealt with in C16, the environmental effects of mineral mining in C4, the impact of fertilisers on the environment in C16, the effects of waste from quarrying and industry in C6 and C4.

Appendix D

The New Teachers' Guide Advice and National Curriculum statements accessed

Extract 1 Sections **B**6.1 and **B**6.2 What would you like for supper tonight? and Why do you need food-and what food do you need?

Routes and times

Basic	Central	Further
Spend more time on this section *1 ¼ hours*	**Worksheet B6A Your daily diet** Omit if time is short. **B6 2 Why do you need food - and what food do you need?** (class and homework) *¾ hour*	Omit Worksheet B6.2 Some of section B6.2 should be done for homework *¼ hour*
	B6.3 Getting the energy balance right Omit Q4 **Worksheet B6B How much energy do you need?** (homework) **B6.5 Controlling your appetite** *½ hour*	All questions are suitable
Omit section B6 4	**B6 4 Everything you need to know about cholesterol** Omit Q13 and 14. **B6.7 Cutting down on salt** **B6 8 The importance of fibre in the diet** **B6 4 Too fat or too thin?** Select material from this section *1 hour*	Q13 from section B6 6 is also suitable *¾ hour*
Total· 2¾ hours	*Total 2¼ hours*	*Total: 1½ hours*

Teachers' Guide Advice

B6.1 "*This section allows pupils to begin to think about what they eat and why. It may be developed by using Worksheet **B**6A.*"

B6.2 "*Sensible patterns of eating could include meat, but need not. The emphasis in this section, and indeed in the whole chapter, is that pupils should think carefully about what they eat and develop balanced diets that suit them.*" [NCCT 1992a p. 81]

Appendix D

Key Stage Three programme of study

Introduction

"They should be encouraged to read purposefully an extended range of secondary sources.

Pupils should be given opportunities to develop their awareness of the importance of science in everyday life, and, building on their earlier experience, their growing knowledge and understanding and their increasing maturity, to study how science is applied in a variety of contexts.

They should begin to make decisions and judgements based on their scientific knowledge of issues concerning personal health and well being....."
[DESWO 1991 p. 13]

Attainment Target 2 Life and living processes

"They should study life processes, feeding (including digestion and assimilation.. [...] particularly as they relate to human beings.

Pupils should extend their study of the ways in which the healthy functioning of the human body may be affected by diet, lifestyle......" [DESWO 1991 p. 16]

Key Stage Four (Double Science) programme of study

Introduction

"They should develop research skills through selecting and using reference materials and through gathering and organising information from a number of sources and perspectives.

"Pupils should be given opportunities to develop awareness of the importance of science in everyday life. Building on earlier experience, breadth of knowledge and understanding, and increased maturity, they should study how science is applied in a variety of contexts......

They should use their science knowledge and skills to make decisions and judgements concerning personal health and safety....." [DESWO 1991 p. 22]

Attainment target 2 Life and living processes

"In the context of their study of the major human organs they should consider factors associated with a healthy life style..." [DESWO 1991 p. 25]

Appendix D

Statements of attainment: Attainment target 2 Life and living processes

"Level 5 a) be able to name and outline the functions of the major organs and organ systems in mammals and in flowering plants.

Level 7 a) understand the life processes of movement, respiration, growth, reproduction, excretion, nutrition and sensitivity in animals."
[DESWO 1991 p. 25]

Appendix D

Extract 2 Section **B**12.4 What goes in must come out

Routes and times

Basic	Central	Further
	B12.1 Not too cold, not too hot **B12.2 Controlling the body's central heating system** **Worksheet B12A A Normal temperature** *1¼ hours*	
Spend more time on this section *1½ hours*	**Worksheet B12B Investigating heat loss from objects of different sizes** Part 2 is optional, omit Q4-6. *1¼ hours*	
		B12 3 Control of blood sugar level *¾ hour*
		Worksheet B12C Investigating the effect of different concentrations of water on blood *Optional/homework*
Omit section B12 4 but discuss the basic function of the kidney Omit Worksheet B12D *½ hour*	**B12 4 What goes in must come out** **Worksheet B12D Your kidneys at work** *1 hour*	
Concentrate on incubators in Worksheet B12D1 *½ hour*	**B12 5 What happens when a kidney fails?** **Worksheet B12D1 Keeping life going** (class + homework) *1 hour*	
		B12.6 Other adjustments **Worksheet B12F Controlling concentrations** (class + homework) *1 hour*
This is suitable for Basic level *¾ hour*	**Worksheet B12E Changes in pulse rate** *Optional*	Omit Worksheet B12E.
Total: 4½ hours	*Total. 4½ hours*	*Total: 6¼ hours*

Teachers' Guide Advice

"*The kidney is considered in this section as a filtration unit. Details of the structure and function of the nephrons are not required. This section can be completed with Worksheet **B**12C, which emphasises that the amount of water inside the body needs to be regulated if damage to cells is to be avoided. The kidney plays a major role in the maintenance of a constant water level in the body. Worksheet **B**12D examines the functioning of the kidneys more fully.*" [NCCT 1992a p. 129]

Appendix D

Key Stage Three programme of study

Introduction

"They should be encouraged to read purposefully an extended range of secondary sources." [DESWO 1991 p. 13]

Attainment target 2 Life and living processes

"Pupils should explore and investigate how flowering plants and mammals are normally organised at cellular and macroscopic levels

They should study life processes,.... [...], removal of waste, ...[...]... particularly as they relate to human beings." [DESWO 1991 p. 16]

Key Stage Four (Double Science) programme of study

Introduction

"They should develop research skills through selecting and using reference materials and through gathering and organising information from a number of sources and perspectives." [DESWO 1991 p. 22]

Attainment target 2 Life and living processes

"Pupils should extend their study of the major organs and organ systems and life processes. They should explore and investigate sensitivity, co-ordination and response

They should explore how the internal environments of plants and animals are maintained, including water relations,.... [...] solute balance, for example,..... [...] .... urea,..[...].." [DESWO 1991 p. 25]

Statements of attainment: Attainment target 2 Life and living processes

"Level 4 a) be able to name and locate the major organs of the human body and the flowering plant.

Level 5 a) be able to name and outline the functions of the major organs and organ systems in mammals and in flowering plants.

Level 7 a) understand the life processes of movement, respiration, growth, reproduction, excretion, nutrition and sensitivity in animals.

Level 8 a) be able to describe how the internal environment in plants animals and the human embryo is maintained.

Appendix D

Level 10 a) understand how homeostatic and metabolic processes contribute to maintaining the internal environment of organisms." [DESWO 1991 p. 25]

Appendix D

Extract 3 Section B18.2 Conservation

Routes and times

Basic	Central	Further
Do only pages 220 and 221 of section B 18 1	**B18 1 Destruction or conservation?** **B18 3 Rare species** (class + homework) *1 hour*	
	Worksheet B18A Conservation (optional) **B18.2 Conservation** Select material to suit class needs *1 hour*	
	Worksheet B18B What to do with waste? (class + homework) *½ hour*	
Total 2½ hours	*Total 2½ hours*	*Total 2½ hours*

Teachers' Guide Advice

"*This section develops the case study of Epping forest as an example of successful conservation. It could be related to similar examples in your area. The principle aim of this section is to show that conservation involves active management of the area. Worksheet **B18A** could be used to replace some or all of the material.*" [NCCT 1992a p. 167]

Key Stage Three programme of study

Introduction

"*They should be encouraged to read purposefully an extended range of secondary sources.*

They should consider the benefits and drawbacks of applying scientific and technological ideas to themselves, industry, the environment and the community. They should begin to make decisions and judgements based on their scientific knowledge of issues concerning .... [...]... and care of the environment. Through this the should begin to understand how science shapes and influences the quality of their lives." [DESWO 1991 p. 13]

Attainment target 2 Life and living processes

Appendix D

Procedure for the administration of the discussion task

Before the date

Ring to confirm a few days before the activity

Check the materials

Check the equipment

Obtain a second tape recorder and check that it works.

Read latest version of profile noting further questions

At the school

Set out the materials

Try the microphones out with the children in position. Remember that some children speak very quietly. Use the children to be studied for this.

Identify the students on the tape

Use the worksheets

Pace the activity

Note down times of starting each part of the task in field notes for each of the groups taped.

Check the materials directly afterwards

At home

Update profile

Write up field notes

Write up transcripts etc

Appendix D

Kit list for the administration of the discussion task

The school folder

Copies of the task instructions sheet

Copies of the task sheet

Sufficient pink Post-Its

Sufficient blue Post-Its

Sufficient blue pens

Sufficient red pens

A3 sheets of sugar paper

Paper to write down concept maps

TWO TAPE RECORDERS

Three tapes

Spare batteries

Four copies of the old edition

Four copies of the new edition

Portfolio

Diary

The schools directory

Appendix D

NUFFIELD CO-ORDINATED SCIENCES RESEARCH PROJECT

Discussion and concept mapping task

Read pages 226 and 227.

Look at the photocopy of the same extract. It has been divided up into numbered sections.

Discuss each section in turn with your partner and decide on the main idea or point contained within it. Write this very briefly, just a few words, on a Post-It and number the Post-It. Make sure that your pair is using a different colour to write with than the other pair.

Arrange your Post-Its on the sheet of paper provided, in a way which the pair of you agree makes the most sensible order.

Record your arrangement as a concept map. Use the section numbers and arrows to show how you linked the ideas together.

Compare your concept map with the other pair's concept map. Discuss the similarities and differences.

Join the two maps to make an overall map agreed by all four of you.

Record this concept map.

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[redacted]

Appendix D

N C S Research Project: Follow Up Questionnaire

School Number................ Student Number..............

Class Number................ Date..........................

This questionnaire concerns the languages you use in various situations. Please choose one of five responses in each case.

A. Always English B. Mainly English

C. Equal amounts of English and another language

D. Mainly another language E. Always another language

Indicate your response by circling the appropriate letter on the right hand side of the sheet.

1. Talking to science teachers.	A	B	C	D	E
2. Talking to students in science lessons.	A	B	C	D	E
3. Reading in science lessons.	A	B	C	D	E
4. Making notes in science lessons.	A	B	C	D	E
5. Planning your science homework.	A	B	C	D	E
6. Revising for science exams.	A	B	C	D	E
7. Talking to friends at break times.	A	B	C	D	E
8. Talking to younger family members and friends at home (e.g. brothers or sisters).	A	B	C	D	E
9. Talking to a parent or guardian.	A	B	C	D	E
10. Talking to older family members and family friends (e.g. grandparents).	A	B	C	D	E
11. Writing letters.	A	B	C	D	E
12. Reading letters.	A	B	C	D	E
13. Using a shopping list.	A	B	C	D	E
14. Buying things in shops.	A	B	C	D	E
15. The language of books, magazines and newspapers you read for pleasure.	A	B	C	D	E
16. The language of the television programmes you watch.	A	B	C	D	E
17. The language of radio programmes which you listen to.	A	B	C	D	E
18. The language of films you go to see.	A	B	C	D	E

Which languages have you referred to apart from English?

.... Thank you

Appendix D

N C S Research Project: Follow up interviews with students

Two groups of 4 Year 11 students at School 1039 were interviewed. The groups were single sex friendship groups with no particular dominant member. Some of the students interviewed were bilingual students. These group discussions took about 20 minutes. All the discussions were tape recorded.

Prioritising activity.

If there was a wide variety of textbooks to work from, which of these features of textbooks would affect your choice of textbook? Arrange them in order of importance.

The use of clear language.

Science in everyday context.

The use of scientific language.

Attractive design.

Clear diagrams.

Scientific diagrams.

A glossary.

Good layout.

A clear structure to the whole book.

Appendix E: Questionnaire and cloze task data

Contents

Appendix E

Table 7.a: Responses to the question "Do you like using the Nuffield Co-ordinated Sciences Biology book?"

Sch No	Total number of students n =			% of students who like using the textbook			% of students who dislike using the textbook		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
1036*	86	85	171	84.9	84.7	84.8	8.1	3.5	5.9
1020*	46	56	102	69.6	89.3	80.4	30.4	5.4	16.7
1031*	165		165	73.3		73.3	21.8		21.8
1010	55	58	113	67.3	72.4	69.9	21.8	6.9	14.2
1004*	35	39	74	68.6	69.2	68.9	25.7	20.5	23.0
1007	65	70	135	78.5	51.4	64.4	10.8	25.7	18.5
1021*	133		133	57.9		57.9	33.1		33.1
1035	84	55	139	51.2	65.5	56.8	38.1	16.4	29.5
1028	82	69	151	57.3	47.8	53.0	24.4	24.6	24.5
1011	92	73	165	47.8	50.7	49.1	38.0	37.0	37.6
1029	41	57	98	41.5	52.6	48.0	41.5	28.1	33.7
1018*	29	45	74	27.6	28.9	28.4	44.8	28.9	35.1

Appendix E

Sch No	% undecided			% nil response		
	Boys	Girls	Total	Boys	Girls	Total
1036*	4.7	11.8	8.2	2.3	0.0	1.2
1020*	0.0	1.8	1.0	0.0	3.6	2.0
1031*	4.2		4.2	0.6		0.6
1010	10.9	19.0	15.0	0.0	1.7	0.9
1004*	5.7	10.3	8.1	0.0	0.0	0.0
1007	7.7	17.1	12.6	3.1	5.2	4.4
1021*	8.3		8.3	0.8		0.8
1035	10.7	18.9	13.7	0.0	0.0	0.0
1028	17.1	27.5	21.9	1.2	0.0	0.7
1011	13.0	12.3	12.7	1.1	0.0	0.6
1029	17.1	15.8	16.3	0.0	3.5	2.0
1018*	27.6	42.2	36.5	0.0	0.0	0.0

Appendix E

Table 7.b: Student approval and class size

Sch & Cs ID	Stud Pres	Student Approval		Class Size	Sch & Cs ID	Stud Pres	Student Approval		Class Size
		n =	%				n =	%	
1035					**1029**				
01	25	21	84.0	25	1	20	12	60.0	24
02	26	15	57.7	30	2	19	6	31.6	20
03	27	13	48.2	28	3	16	11	68.8	19
04	23	12	52.2	23	4	17	5	29.4	19
05	17	11	64.7	19	5	16	9	56.3	20
06	7	3	42.9	12	6	10	4	40.0	12
07	14	4	28.6	15					
1036*					**1004***				
B	12	12	100.0	14	Blue	14	5	35.7	15
C	14	10	71.4	18	Gren	16	13	81.3	16
D	16	14	87.5	19	Red	14	12	85.7	14
F	20	19	95.0	22	Viol	14	10	71.4	15
G	16	13	81.3	22	Yell	16	11	68.8	17
L	14	12	85.7	19					
P	13	12	92.3	19					
T	16	13	81.3	18					
W	16	14	87.5	19					
Y	18	13	72.2	20					
Z	16	13	81.3	19					

(Sch & Cs ID = School and class identifier, Stud pres = number of students present, Class size = number of students on register)

Appendix E

Sch & Cs ID	Stud Pres	Student Approval		Class Size	Sch & Cs ID	Stud Pres	Student Approval		Class Size
		n =	%				n =	%	
1028					**1011**				
X1	29	15	51.7	30	A/C	18	4	22.2	22
X2	28	20	71.4	29	A/J	21	11	52.4	24
X3	19	8	42.1	24	A/M	19	13	68.4	23
Y1	30	16	53.3	31	A/R	22	5	22.7	24
Y2	23	15	65.2	25	A/S	15	7	46.7	22
Y3	22	6	27.3	24	B/H	17	9	52.9	25
					B/J	19	18	94.7	22
					B/M	19	7	36.8	24
					B/S	15	7	46.7	21
1020*					**1010**				
3CS3	24	21	87.5	25	10A	21	12	57.1	24
4CS1	24	18	75.0	27	10F	23	18	78.3	26
4CS2	17	15	88.2	21	10G	24	19	79.2	28
5CS1	20	11	55.0	25	10H	24	13	54.2	31
5CS2	17	17	100.0	27	10J	21	17	81.0	29

(Sch & Cs ID = School and class identifier, Stud pres = number of students present, Class size = number of students on register)

Appendix E

Sch & Cs ID	Stud Pres	Student Approval		Class Size	Sch & Cs ID	Stud Pres	Student Approval		Class Size
		n =	%				n =	%	
1018*					**1007**				
94M1	25	14	53.3	26	93B	13	7	53.9	19
95M1	24	7	29.2	27	93E	12	8	66.7	18
95R1	25	0	0.0	25	94A	14	6	42.9	19
					94B	22	16	72.7	22
					94C	21	11	52.4	23
					94D	21	16	76.2	23
					94E	16	10	62.5	22
					94F	16	13	81.3	21
1021*					**1031***				
34BY	20	14	70.0	25	94B4	23	17	73.9	25
4.1	25	13	52.0	25	95A1	24	18	75.0	27
4.2M	21	11	52.4	24	95A2	28	19	67.9	28
4.2R	17	8	47.1	22	95A3	18	11	61.1	21
4.3K	20	16	80.0	22	95B4	26	20	76.9	26
4.3S	16	6	37.5	18	95B5	25	18	72.0	25
4.3T	14	9	64.3	18	95B6	21	18	85.7	22

(Sch & Cs ID = School and class identifier, Stud pres = number of students present, Class size = number of students on register)

Appendix E

Table 7.c: Student judgements of subject narrative.

Sch & Cs ID	Stud Pres	Subject narrative							
		Fav		Unf		Imp		MHS	MDS
		n =	%	n =	%	n =	%		
1035									
01	25	6	24.0	1	4.0	2	8.0	6	73
02	26	1	3.9	2	7.7	2	7.7	73	73
03	27	1	3.7	0	0.0	1	3.7	73	73
04	23	3	13.0	0	0.0	1	4.4	6	8
05	17	0	0.0	0	0.0	0	0.0	82	12
06	7	0	0.0	0	0.0	1	14.3	51	10
07	14	0	0.0	0	0.0	1	7.1	73	73
1029									
1	20	1	5.0	0	0.0	0	0.0	73	73
2	19	2	10.5	1	5.3	0	0.0	71	22
3	16	3	18.8	0	0.0	0	0.0	73	51
4	17	0	0.0	0	0.0	1	5.9	73	81
5	16	3	18.8	0	0.0	1	6.3	71	81
6	10	2	20.0	0	0.0	1	10.0	71	51

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements, MHS = Most Helpful Section, MDS = Most Difficult Section)

Appendix E

Sch & Cs ID	Stud Pres	Subject narrative							
		Fav		Unf		Imp		MHS	MDS
		n =	%	n =	%	n =	%		
1036*									
B	12	2	16.7	0	0.0	0	0.0	51	82
C	14	2	14.3	0	0.0	0	0.0	73	10
D	16	2	12.5	0	0.0	0	0.0	51	61
F	20	0	0.0	0	0.0	1	5.0	6	71
G	16	2	12.5	0	0.0	1	6.3	51	71
L	14	1	7.1	2	14.3	5	35.7	51	3
P	13	0	0.0	1	7.7	1	7.7	51	9
T	16	2	12.5	0	0.0	3	18.8	51	71
W	16	1	6.3	0	0.0	5	31.3	81	71
Y	18	1	5.6	2	11.1	2	11.1	51	15
Z	16	4	25.0	0	0.0	3	18.8	11	71
1004*									
Blue	14	2	14.3	3	21.4	4	28.6	3	3
Gren	16	1	6.3	0	0.0	1	6.3	3	8
Red	14	1	7.1	1	7.1	1	7.1	71	3
Viol	14	3	21.4	0	0.0	4	28.6	5	3
Yell	16	1	6.3	5	31.3	5	31.3	71	71
1028									
X1	29	2	6.9	1	3.5	1	3.5	14	2
X2	28	2	7.1	1	3.6	2	7.1	51	3
X3	19	0	0.0	0	0.0	0	0.0	71	61
Y1	30	1	3.3	2	6.7	5	16.7	51	3
Y2	23	3	13.0	0	0.0	1	4.4	82	61
Y3	22	0	0.0	0	0.0	0	0.0	71	73

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements, MHS = Most Helpful Section, MDS = Most Difficult Section)

Appendix E

Sch & Cs ID	Stud Pres	Subject narrative							
		Fav		Unf		Imp		MHS	MDS
		n =	%	n =	%	n =	%		
1011									
A/C	18	0	0.0	0	0.0	0	0.0	71	71
A/J	21	1	4.8	0	0.0	3	14.3	5	73
A/M	19	1	5.3	1	5.3	2	10.5	71	71
A/R	22	1	4.6	3	13.6	2	9.1	71	71
A/S	15	2	13.3	0	0.0	0	0.0	5	73
B/H	17	2	11.8	0	0.0	1	5.9	3	73
B/J	19	2	10.5	2	10.5	6	31.6	7	73
B/M	19	2	10.5	1	5.3	0	0.0	73	73
B/S	15	0	0.0	0	0.0	0	0.0	51	81
1020*									
3CS3	24	8	33.3	0	0.0	5	20.8	8	71
4CS1	24	2	8.3	2	8.3	7	29.2	5	18
4CS2	17	0	0.0	0	0.0	7	41.2	6	71
5CS1	20	0	0.0	9	45.0	7	35.0	61	82
5CS2	17	2	11.8	4	23.5	7	41.2	6	8
1010									
10A	21	0	0.0	0	0.0	2	9.5	73	73
10F	23	0	0.0	0	0.0	3	13.0	15	73
10G	24	1	4.2	1	4.2	1	4.2	6	18
10H	24	2	8.3	1	4.2	7	29.2	3	71
10J	21	0	0.0	0	0.0	3	14.3	3	51

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements, MHS = Most Helpful Section, MDS = Most Difficult Section)

Appendix E

Sch & Cs ID	Stud Pres	Subject narrative							
		Fav		Unf		Imp		MHS	MDS
		n =	%	n =	%	n =	%		
1018*									
94M1	25	1	4.0	0	0.0	3	12.0	7	18
95M1	24	2	8.3	2	8.3	1	4.2	73	73
95R1	25	4	16.0	2	8.0	4	16.0	73	52
1007									
93B	13	0	0.0	0	0.0	2	15.4	9	71
93E	12	0	0.0	1	8.3	2	16.7	3	61
94A	14	1	7.1	0	0.0	0	0.0	51	71
94B	22	2	9.1	1	4.6	3	13.6	6	3
94C	21	1	4.8	0	0.0	1	4.8	5	3
94D	21	0	0.0	2	9.5	4	19.1	5	8
94E	16	0	0.0	2	12.5	2	12.5	5	71
94F	16	0	0.0	3	18.8	2	12.5	3	71
1021*									
34BY	20	0	0.0	6	30.0	8	40.0	10	11
4.1	25	0	0.0	9	36.0	14	56.0	71	8
4.2M	21	1	4.8	7	33.3	7	33.3	7	71
4.2R	17	0	0.0	3	17.7	6	35.3	6	71
4.3K	20	0	0.0	0	0.0	1	5.0	3	71
4.3S	16	0	0.0	3	18.8	2	12.5	51	82
4.3T	14	0	0.0	1	7.1	1	7.1	71	71

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements, MHS = Most Helpful Section, MDS = Most Difficult Section)

Appendix E

Sch & Cs ID	Stud Pres	Subject narrative							
		Fav		Unf		Imp		MHS	MDS
		n =	%	n =	%	n =	%		
1031*									
94B4	23	4	17.4	9	39.1	10	43.5	5	71
95A1	24	1	4.2	6	25.0	11	45.8	11	71
95A2	28	0	0.0	7	25.0	8	28.6	71	71
95A3	18	3	16.7	1	5.6	3	16.7	51	71
95B4	26	2	7.7	2	7.7	3	11.5	10	73
95B5	25	3	12.0	1	4.0	7	28.0	10	8
95B6	21	1	4.8	1	4.8	7	33.3	11	10

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements,
MHS = Most Helpful Section, MDS = Most Difficult Section.
MHS and MDS section headings and subject codes; 2 Many forms of life,
3 Light means life, 5 The gut as a food processor, 6 Diet and good health,*
7 The breath of life, 8 Transport round the organism, 9 Keeping going,
*10 Skeletons and muscles, 11 Detecting change, 12 Keeping things under control**
14 The webs of life, 15 Salts and cycles, 18 To destroy or to conserve,*
22 Handing on to the next generation, 51 The body, 52 Health, 61 Plants,
71 None, 73 Don't know (can't remember), 81 All, 82 Most.
The sections marked with an asterisk contain material used as a cloze task*
- see section 6.3.)

Appendix E

Table 7.d: Student judgements of teaching discourse.

Sch & Cs ID	Stud Pres	Teaching discourse					
		Fav		Unf		Imp	
		n =	%	n =	%	n =	%
1035							
01	25	1	4.0	2	8.0	3	12.0
02	26	1	3.9	6	23.1	5	19.2
03	27	0	0.0	1	3.7	8	29.6
04	23	0	0.0	1	4.4	0	0.0
05	17	0	0.0	0	0.0	0	0.0
06	7	0	0.0	0	0.0	0	0.0
07	14	2	14.3	1	7.1	1	7.1
1029							
1	20	1	5.0	3	15.0	5	25.0
2	19	2	10.5	4	21.1	3	15.8
3	16	0	0.0	1	6.3	0	0.0
4	17	0	0.0	2	11.8	2	11.8
5	16	0	0.0	0	0.0	0	0.0
6	10	0	0.0	1	10.0	1	10.0

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Sch & Cs ID	Stud Pres	Teaching discourse					
		Fav		Unf		Imp	
		n =	%	n =	%	n =	%
1036*							
B	12	0	0.0	0	0.0	0	0.0
C	14	0	0.0	0	0.0	0	0.0
D	16	0	0.0	0	0.0	0	0.0
F	20	0	0.0	0	0.0	0	0.0
G	16	0	0.0	0	0.0	0	0.0
L	14	1	7.1	1	7.1	0	0.0
P	13	0	0.0	0	0.0	1	7.7
T	16	1	6.3	2	12.5	2	12.5
W	16	0	0.0	0	0.0	0	0.0
Y	18	0	0.0	5	27.8	9	50.0
Z	16	4	25.0	4	25.0	4	25.0
1004*							
Blue	14	0	0.0	5	35.7	1	7.1
Gren	16	2	12.5	0	0.0	0	0.0
Red	14	0	0.0	3	21.4	3	21.4
Viol	14	0	0.0	0	0.0	1	7.1
Yell	16	0	0.0	3	18.3	1	6.3
1028							
X1	29	0	0.0	2	6.9	2	6.9
X2	28	4	14.3	0	0.0	1	3.6
X3	19	0	0.0	1	5.3	0	0.0
Y1	30	1	3.3	10	33.3	4	13.3
Y2	23	0	0.0	0	0.0	1	4.4
Y3	22	0	0.0	0	0.0	0	0.0

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Sch & Cs ID	Stud Pres	Teaching discourse					
		Fav		Unf		Imp	
		n =	%	n =	%	n =	%
1011							
A/C	18	0	0.0	0	0.0	1	5.6
A/J	21	1	4.8	3	14.3	4	19.1
A/M	19	0	0.0	0	0.0	2	10.5
A/R	22	0	0.0	11	50.0	5	22.7
A/S	15	0	0.0	0	0.0	0	0.0
B/H	17	0	0.0	0	0.0	0	0.0
B/J	19	0	0.0	0	0.0	0	0.0
B/M	19	0	0.0	0	0.0	1	5.3
B/S	15	0	0.0	0	0.0	1	6.7
1020*							
3CS3	24	0	0.0	1	4.2	2	8.3
4CS1	24	0	0.0	0	0.0	0	0.0
4CS2	17	0	0.0	0	0.0	2	11.8
5CS1	20	1	5.0	0	0.0	0	0.0
5CS2	17	0	0.0	0	0.0	0	0.0
1010							
10A	21	0	0.0	0	0.0	0	0.0
10F	23	0	0.0	0	0.0	1	4.4
10G	24	4	16.7	1	4.2	1	4.2
10H	24	0	0.0	0	0.0	0	0.0
10J	21	0	0.0	3	14.3	3	14.3

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Sch & Cs ID	Stud Pres	Teaching discourse					
		Fav		Unf		Imp	
		n =	%	n =	%	n =	%
1018*							
94M1	25	0	0.0	6	24.0	0	0.0
95M1	24	0	0.0	0	0.0	0	0.0
95R1	25	0	0.0	4	16.0	0	0.0
1007							
93B	13	0	0.0	1	7.7	1	7.7
93E	12	0	0.0	1	8.3	3	25.0
94A	14	1	7.1	0	0.0	0	0.0
94B	22	2	9.1	2	9.1	0	0.0
94C	21	0	0.0	2	9.5	4	19.1
94D	21	0	0.0	1	4.8	2	9.5
94E	16	2	12.5	4	25.0	2	12.5
94F	16	0	0.0	1	6.3	1	6.3
1021*							
34BY	20	0	0.0	5	25.0	6	30.0
4.1	25	0	0.0	9	36.0	2	8.0
4.2M	21	0	0.0	5	23.8	4	19.1
4.2R	17	0	0.0	2	11.8	4	23.5
4.3K	20	2	10.0	0	0.0	2	10.0
4.3S	16	0	0.0	1	6.3	1	6.3
4.3T	14	1	7.1	0	0.0	3	21.4

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Sch & Cs ID	Stud Pres	Teaching discourse					
		Fav		Unf		Imp	
		n =	%	n =	%	n =	%
1031*							
94B4	23	2	8.7	4	17.4	1	4.4
95A1	24	3	12.5	1	4.2	1	4.2
95A2	28	2	7.1	3	10.7	5	17.9
95A3	18	2	11.1	2	11.1	2	11.1
95B4	26	1	3.9	0	0.0	0	0.0
95B5	25	4	16.0	3	12.0	8	32.0
95B6	21	1	4.8	1	4.8	5	23.8

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Table 7.e: Student judgements about language and communication and student multilingualism.

Sch & Cs ID	Stud Pres	Language and communication						Bi & multi lingual students		Number of languages spoken excluding English
		Fav		Unf		Imp				
		n =	%	n =	%	n =	%	n =	%	
1035										
01	25	14	56.0	5	20.0	6	24.0	0	0.0	0
02	26	11	42.3	8	30.8	16	61.5	1	3.9	1
03	27	4	14.8	6	22.2	13	48.2	0	0.0	0
04	23	8	34.8	4	17.4	13	56.5	3	13.0	3
05	17	6	35.3	0	0.0	9	52.9	1	5.9	4
06	7	2	28.6	0	0.0	6	85.7	0	0.0	0
07	14	2	14.3	1	7.1	12	85.7	1	7.1	1
1029										
1	20	7	35.0	4	20.0	7	35.0	2	10.0	2
2	19	7	36.8	4	21.1	7	36.8	0	0.0	0
3	16	2	12.5	4	25.0	10	62.5	1	6.3	2
4	17	2	11.8	3	17.7	10	58.8	1	5.9	1
5	16	8	50.0	0	0.0	6	37.5	3	18.8	3
6	10	4	40.0	1	10.0	7	70.0	1	10.0	1

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Sch & Cs ID	Stud Pres	Language and communication						Bi & multi lingual students		Number of languages spoken excluding English
		Fav		Unf		Imp				
		n =	%	n =	%	n =	%	n =	%	
1036*										
B	12	9	75.0	0	0.0	6	50.0	2	16.7	2
C	14	8	57.1	0	0.0	11	78.6	3	21.4	3
D	16	6	37.5	1	6.3	9	56.3	3	12.5	2
F	20	10	50.0	0	0.0	10	50.0	2	10.0	2
G	16	4	25.0	1	6.3	6	37.5	2	12.5	2
L	14	5	35.7	0	0.0	7	50.0	2	14.3	2
P	13	5	38.5	0	0.0	7	53.9	0	0.0	0
T	16	6	37.5	4	25.0	7	43.8	2	12.5	3
W	16	10	62.5	2	12.5	13	81.3	3	18.8	2
Y	18	10	55.6	3	16.7	10	55.6	0	0.0	0
Z	16	7	43.8	4	25.0	7	43.8	0	0.0	0
1004*										
Blue	14	4	28.6	2	14.3	8	57.1	4	28.6	4
Gren	16	12	75.0	2	12.5	10	62.5	7	43.8	8
Red	14	11	78.6	0	0.0	7	50.0	5	35.7	5
Viol	14	4	28.6	3	21.4	7	50.0	5	35.7	6
Yell	16	6	37.5	3	18.8	10	62.5	3	18.8	3

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Sch & Cs ID	Stud Pres	Language and communication						Bi & multi lingual students		Number of languages spoken excluding English
		Fav		Unf		Imp				
		n =	%	n =	%	n =	%	n =	%	
1028										
X1	29	5	17.2	5	17.2	15	51.7	1	3.5	1
X2	28	3	10.7	0	0.0	13	46.4	0	0.0	0
X3	19	1	5.3	3	15.8	6	31.6	0	0.0	0
Y1	30	10	33.3	7	23.3	17	56.7	0	0.0	0
Y2	23	3	13.0	2	8.7	11	47.8	0	0.0	0
Y3	22	2	9.1	2	9.1	3	13.6	1	4.6	1
1011										
A/C	18	5	27.8	3	16.7	9	50.0	2	11.1	6
A/J	21	2	9.5	10	47.6	13	61.9	2	9.5	2
A/M	19	9	47.4	3	15.8	11	57.9	0	0.0	0
A/R	22	6	27.3	10	45.5	15	68.2	1	4.6	1
A/S	15	5	33.3	1	6.7	11	73.3	1	6.7	2
B/H	17	4	23.5	4	23.5	13	76.5	0	0.0	0
B/J	19	7	36.8	2	10.5	11	57.9	0	0.0	0
B/M	19	5	26.3	1	5.3	10	52.6	0	0.0	0
B/S	15	8	53.3	2	13.3	8	53.3	3	20.0	2
1020*										
3CS3	24	9	37.5	4	16.7	17	70.8	14	58.3	5
4CS1	24	6	25.0	4	16.7	15	62.5	7	29.2	5
4CS2	17	5	29.4	0	0.0	9	52.9	9	52.9	7
5CS1	20	1	5.0	5	25.0	9	45.0	9	45.0	4
5CS2	17	5	29.4	4	23.5	8	47.1	7	41.2	2

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Sch & Cs ID	Stud Pres	Language and communication						Bi & multi lingual students		Number of languages spoken excluding English
		Fav		Unf		Imp				
		n =	%	n =	%	n =	%	n =	%	
1010										
10A	21	5	23.8	1	4.8	11	52.4	1	4.8	1
10F	23	8	34.8	0	0.0	11	47.8	4	17.4	2
10G	24	6	25.0	2	8.3	14	58.3	2	8.3	1
10H	24	8	33.3	4	16.7	13	54.2	3	12.5	3
10J	21	10	47.6	4	19.1	13	61.9	1	4.8	1
1018*										
94M1	25	15	60.0	21	84.0	22	88.0	23	92.0	2
95M1	24	0	0.0	7	29.2	9	37.5	20	83.0	2
95R1	25	2	8.0	19	76.0	22	88.0	21	84.0	4
1007										
93B	13	6	46.2	1	7.7	7	53.9	4	30.8	4
93E	12	4	33.3	0	0.0	6	50.0	1	8.3	1
94A	14	2	14.3	3	21.4	8	57.1	0	0.0	0
94B	22	13	59.1	5	22.7	14	63.6	1	4.6	2
94C	21	6	28.6	2	9.5	13	61.9	3	9.5	2
94D	21	8	38.1	1	4.8	9	42.9	3	9.5	2
94E	16	6	37.5	3	18.8	11	68.8	0	0.0	0
94F	16	8	50.0	5	31.3	10	62.5	1	6.5	1

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Sch & Cs ID	Stud Pres	Language and communication						Bi & multi lingual students		Number of languages spoken excluding English
		Fav		Unf		Imp				
		n =	%	n =	%	n =	%	n =	%	
1021*										
34BY	20	10	50.0	5	25.0	12	60.0	9	45.0	7
4.1	25	18	72.0	10	40.0	18	72.0	7	28.0	11
4.2M	21	10	47.6	3	14.3	17	81.0	5	23.8	4
4.2R	17	8	47.1	4	23.5	11	64.7	8	47.1	11
4.3K	20	10	50.0	3	15.0	15	75.0	5	25.0	5
4.3S	16	5	31.3	3	18.8	12	75.0	4	25.0	4
4.3T	14	3	21.4	3	21.4	12	85.7	5	35.7	5
1031*										
94B4	23	11	47.8	2	8.7	13	56.5	10	43.5	6
95A1	24	7	29.2	3	12.5	16	66.7	1	4.2	2
95A2	28	14	50.0	3	10.7	19	67.9	6	21.4	5
95A3	18	9	50.0	1	5.6	7	38.9	1	5.6	1
95B4	26	9	34.6	5	19.3	20	76.9	1	3.9	1
95B5	25	12	48.0	4	16.0	15	60.0	5	20.0	4
95B6	21	9	42.9	2	9.5	12	57.1	6	28.6	5

(Fav = Favourable, Unf = Unfavourable, Imp = Improvements)

Appendix E

Table 7.f: Student judgements of how they use the textbook.

Sch & Cs ID	Stud Pres	BR		AQ		MN		CD		O	
		n =	%	n =	%	n =	%	n =	%	n =	%
1035											
01	25	21	84.0	17	68.0	7	28.0	13	52.0	1	4.0
02	26	10	38.5	18	69.2	13	50.0	23	88.5	0	0.0
03	27	3	11.1	24	88.9	16	59.3	25	92.6	1	3.7
04	23	5	21.7	19	82.6	17	73.9	20	87.0	0	0.0
05	17	6	35.3	9	52.9	8	47.1	17	100	1	5.9
06	7	2	28.6	4	57.1	0	0.0	6	85.7	0	0.0
07	14	1	7.1	11	78.6	3	21.4	12	85.7	1	7.1
1029											
1	20	18	90.0	11	55.0	0	0.0	1	5.0	0	0.0
2	19	16	84.2	7	36.8	0	0.0	2	10.5	0	0.0
3	16	6	37.6	12	75.0	3	18.8	5	31.3	1	6.3
4	17	11	64.7	12	70.6	3	17.7	9	53.0	0	0.0
5	16	8	50.0	10	62.5	5	31.3	11	68.8	2	12.5
6	10	5	50.0	5	50.0	1	10.0	3	30.0	1	10.0

(BR = Background Reading, AQ = Answering Questions, MN = Making Notes, O = in anOther way)

Appendix E

Sch & Cs ID	Stud Pres	BR		AQ		MN		CD		O	
		n =	%	n =	%	n =	%	n =	%	n =	%
1036*											
B	12	2	16.7	10	83.3	12	100	9	75.0	0	0.0
C	14	2	14.3	14	100	13	92.9	14	100	0	0.0
D	16	11	68.8	12	75.0	15	93.8	13	81.3	1	6.3
F	20	7	35.0	16	80.0	19	95.0	16	80.0	0	0.0
G	16	15	93.8	12	75.0	16	100	15	93.8	0	0.0
L	14	6	42.9	14	100	13	92.9	11	78.6	0	0.0
P	13	2	15.4	13	100	13	100	7	53.9	0	0.0
T	16	1	6.3	15	93.8	16	100	12	75.0	0	0.0
W	16	7	43.8	12	75.0	16	100	12	75.0	0	0.0
Y	18	10	55.6	17	94.4	17	94.4	13	72.2	1	5.6
Z	16	12	75.0	13	81.3	16	100	13	81.3	1	6.3
1004*											
Blue	14	12	85.7	11	78.6	3	21.4	12	85.7	1	7.1
Gren	16	12	75.0	12	75.0	10	62.5	8	50.0	0	0.0
Red	14	12	85.7	12	85.7	3	21.4	12	85.7	0	0.0
Viol	14	13	92.9	8	57.1	8	57.1	8	57.1	2	14.3
Yell	16	9	56.3	15	93.8	6	37.5	5	31.5	2	12.5

(BR = Background Reading, AQ = Answering Questions, MN = Making Notes, O = in anOther way)

Appendix E

Sch & Cs ID	Stud Pres	BR		AQ		MN		CD		O	
		n =	%	n =	%	n =	%	n =	%	n =	%
1028											
X1	29	12	41.4	28	96.6	7	24.1	8	27.6	3	10.3
X2	28	14	50.0	28	100	10	35.7	17	60.7	0	0.0
X3	19	8	42.1	15	79.0	3	15.8	5	26.3	1	5.3
Y1	30	24	80.0	28	93.3	14	46.7	5	16.7	3	10.0
Y2	23	16	69.6	20	87.0	5	21.7	9	39.1	0	0.0
Y3	22	2	9.1	22	100	4	18.2	9	40.9	0	0.0
1011											
A/C	18	7	38.9	10	55.6	12	66.7	7	38.9	0	0.0
A/J	21	10	47.6	20	95.2	13	61.9	16	76.2	0	0.0
A/M	19	8	42.1	18	94.7	8	42.1	14	73.7	0	0.0
A/R	22	6	27.3	16	72.7	8	36.4	8	36.4	0	0.0
A/S	15	6	40.0	8	53.3	7	46.7	15	100	1	6.7
B/H	17	5	29.4	12	70.6	5	29.4	8	47.1	1	5.9
B/J	19	6	31.6	9	47.4	6	31.6	13	68.4	0	0.0
B/M	19	3	15.8	14	73.7	7	36.8	11	57.9	0	0.0
B/S	15	11	73.3	10	66.7	10	66.7	15	100	0	0.0
1020*											
3CS3	24	13	54.2	22	91.7	18	75.0	16	66.7	2	8.3
4CS1	24	19	76.2	14	58.3	15	62.5	14	58.3	0	0.0
4CS2	17	7	41.2	12	70.6	12	70.6	9	53.0	0	0.0
5CS1	20	7	35.0	17	85.0	8	40.0	11	55.0	0	0.0
5CS2	17	5	29.4	14	82.4	12	70.6	11	64.7	4	23.5

(BR = Background Reading, AQ = Answering Questions, MN = Making Notes, O = in anOther way)

Appendix E

Sch & Cs ID	Stud Pres	BR		AQ		MN		CD		O	
		n =	%	n =	%	n =	%	n =	%	n =	%
1010											
10A	21	7	33.3	21	100	17	81.0	18	85.7	0	0.0
10F	23	11	47.8	17	73.9	17	73.9	21	91.3	0	0.0
10G	24	7	29.2	17	70.8	14	58.3	14	58.3	1	4.2
10H	24	9	37.5	15	62.5	11	45.8	21	87.5	0	0.0
10J	21	5	23.8	21	100	7	33.3	7	33.3	0	0.0
1018*											
94M1	25	9	36.0	18	72.0	25	100	23	92.0	0	0.0
95M1	24	5	20.8	7	29.2	23	95.8	8	33.3	0	0.0
95R1	25	5	20.0	19	76.0	24	96.0	15	60.0	1	4.0
1007											
93B	13	10	76.9	11	84.6	2	15.4	1	7.7	0	0.0
93E	12	6	50.0	10	83.3	2	16.7	2	16.7	0	0.0
94A	14	12	85.7	4	28.6	7	50.0	10	71.4	0	0.0
94B	22	12	54.6	22	100	6	27.3	2	9.1	0	0.0
94C	21	18	85.7	15	71.4	3	14.3	4	19.1	4	19.1
94D	21	21	100	18	85.7	11	52.4	8	38.1	1	4.8
94E	16	15	93.8	10	62.5	6	37.5	11	68.8	1	6.3
94F	16	16	100	14	87.5	6	37.5	8	50.0	1	6.3

(BR = Background Reading, AQ = Answering Questions, MN = Making Notes, O = in anOther way)

Appendix E

Sch & Cs ID	Stud Pres	BR		AQ		MN		CD		O	
		n =	%	n =	%	n =	%	n =	%	n =	%
1021*											
34BY	20	15	75.0	10	50.0	8	40.0	3	15.0	4	20.0
4.1	25	16	64.0	16	64.0	1	4.0	8	32.0	2	8.0
4.2M	21	16	76.2	7	33.3	3	14.3	6	28.6	3	14.3
4.2R	17	10	58.8	10	58.8	3	17.7	8	47.1	1	5.9
4.3K	20	10	50.0	17	85.0	3	15.0	6	30.0	1	5.0
4.3S	16	8	50.0	7	43.8	1	6.3	5	31.3	6	37.5
4.3T	14	8	57.1	7	50.0	0	0.0	1	7.1	1	7.1
1031*											
94B4	23	8	34.8	6	26.1	13	56.5	18	78.3	1	4.4
95A1	24	17	70.8	14	58.3	17	70.8	24	100	1	4.2
95A2	28	7	25.0	13	46.4	22	78.6	21	75.0	5	17.9
95A3	18	10	55.6	8	44.4	9	50.0	15	83.3	2	11.1
95B4	26	11	42.3	23	88.5	20	76.9	11	42.3	3	11.5
95B5	25	13	52.0	19	76.0	19	76.0	12	48.0	3	12.0
95B6	21	11	52.4	18	85.7	21	100	20	95.2	1	4.8

(BR = Background Reading, AQ = Answering Questions, MN = Making Notes, O = in anOther way

Appendix E

Table 7.g: Frequency of use, where used and access.

Sch & Cs ID	Stud Pres	Freq of use ind	Where textbook is used						Access
			Class		Home		Both		
			n =	%	n =	%	n =	%	
1035									
01	25	0.4	6	24.0	1	4.0	17	68.0	Books
02	26	0.2	6	23.1	1	3.9	19	73.1	issued
03	27	0.1	15	55.6	0	0.0	12	44.4	for the
04	23	0.3	10	43.5	1	4.4	12	52.2	whole of
05	17	0.4	9	52.9	1	5.9	7	41.2	Key
06	7	0.1	6	85.7	0	0.0	1	14.3	Stage
07	14	0.4	11	78.6	1	7.1	2	14.3	Four
1029									
1	20	0.4	16	80.0	0	0.0	4	20.0	Books
2	19	0.4	19	100	0	0.0	0	0.0	for loan
3	16	0.4	13	81.3	0	0.0	2	12.5	but not
4	17	0.7	15	88.2	0	0.0	1	5.9	issued
5	16	0.3	14	87.5	0	0.0	1	6.3	for long
6	10	0.4	10	100	0	0.0	0	0.0	periods

(Freq of use ind = Frequency of use index)

Appendix E

Sch & Cs ID	Stud Pres	Freq of use ind	Where textbook is used						Access
			Class		Home		Both		
			n =	%	n =	%	n =	%	
1036*									
B	12	0.8	12	100	0	0.0	0	0.0	Books
C	14	0.6	14	100	0	0.0	0	0.0	issued
D	16	0.7	16	100	0	0.0	0	0.0	for
F	20	0.8	19	95.0	0	0.0	1	5.0	modules
G	16	1.2	15	93.8	0	0.0	1	6.3	currently
L	14	1.2	3	21.4	1	7.1	10	71.4	studied
P	13	0.9	2	15.4	0	0.0	11	84.6	and then
T	16	0.9	5	31.3	0	0.0	11	68.8	returned
W	16	1.6	1	6.3	0	0.0	14	87.5	
Y	18	1.7	0	0.0	0	0.0	18	100	
Z	16	1.6	5	31.3	0	0.0	11	68.8	
1004*									
Blue	14	1.4	1	7.1	2	14.3	11	78.6	Books
Gren	16	0.9	1	6.3	2	12.5	12	75.0	issued for
Red	14	0.9	4	28.6	0	0.0	10	71.4	the whole
Viol	14	0.9	3	21.4	2	14.3	9	64.3	of Key
Yell	16	0.7	3	18.8	6	37.5	7	43.8	Stage Four
1028									
X1	29	1.0	6	20.7	1	3.5	22	75.9	Books
X2	28	0.4	14	50.0	0	0.0	14	50.0	issued
X3	19	0.3	14	73.7	3	15.8	2	10.5	for the
Y1	30	0.9	9	30.0	1	3.3	20	66.7	whole of
Y2	23	0.9	18	78.3	0	0.0	5	21.7	Key Stage
Y3	22	0.7	18	81.8	2	9.1	2	9.1	Four

(Freq of use ind = Frequency of use index)

Appendix E

Sch & Cs ID	Stud Pres	Freq of use ind	Where textbook is used						Access
			Class		Home		Both		
			n =	%	n =	%	n =	%	
1011									
A/C	18	0.1	15	83.3	2	11.1	0	0.0	Copies of
A/J	21	0.1	21	100	0	0.0	0	0.0	the book
A/M	19	0.0	18	94.7	0	0.0	0	0.0	available
A/R	22	0.0	22	100	0	0.0	0	0.0	in the
A/S	15	0.3	15	100	0	0.0	0	0.0	library
B/H	17	0.4	16	94.1	0	0.0	0	0.0	and for
B/J	19	0.4	19	100	0	0.0	0	0.0	short term
B/M	19	0.1	17	89.5	0	0.0	1	5.3	loan but
B/S	15	1.0	15	100	0	0.0	0	0.0	not issued
1020*									
3CS3	24	0.8	2	8.3	5	20.8	17	70.8	Books
4CS1	24	0.1	4	16.7	4	16.7	15	62.5	issued for
4CS2	17	0.8	1	5.9	9	52.9	7	41.2	whole of
5CS1	20	0.3	2	10.0	10	50.0	8	40.0	Key Stage
5CS2	17	1.1	1	5.9	4	23.5	12	70.6	Four
1010									
10A	21	0.1	14	66.7	1	4.8	6	28.6	One set of
10F	23	0.1	20	87.0	0	0.0	3	13.0	books in
10G	24	0.1	18	75.0	0	0.0	0	0.0	Dept. No
10H	24	0.0	15	62.5	2	8.3	7	29.2	books
10J	21	0.1	15	71.4	0	0.0	6	28.6	issued

(Freq of use ind = Frequency of use index)

Appendix E

Sch & Cs ID	Stud Pres	Freq of use ind	Where textbook is used						Access
			Class		Home		Both		
			n =	%	n =	%	n =	%	
1018*									
94M1	25	0.0	25	100	0	0.0	0	0.0	Books not
95M1	24	0.0	24	100	0	0.0	0	0.0	issued
95R1	25	0.0	25	100	0	0.0	0	0.0	
1007									
93B	13	0.1	5	38.5	0	0.0	8	61.5	Books
93E	12	0.7	7	58.3	1	8.3	4	33.3	issued
94A	14	0.7	8	57.1	0	0.0	6	42.9	for whole
94B	22	0.6	8	36.4	3	13.6	11	50.0	of Key
94C	21	0.8	15	71.4	0	0.0	6	28.6	Stage
94D	21	0.4	12	57.1	0	0.0	9	42.9	Four
94E	16	1.3	8	50.0	0	0.0	7	43.8	
94F	16	1.1	8	50.0	1	6.3	7	43.8	
1021*									
34BY	20	1.2	8	40.0	3	15.0	9	45.0	Books
4.1	25	0.4	3	12.0	16	64.0	6	24.0	issued for
4.2M	21	1.1	5	23.8	4	19.1	12	57.1	the whole
4.2R	17	0.9	7	41.2	1	5.9	9	52.9	of Key
4.3K	20	0.7	1	5.0	9	45.0	10	50.0	Stage Four
4.3S	16	0.9	7	43.8	1	6.3	7	43.8	plus other
4.3T	14	1.1	7	50.0	2	14.3	5	35.7	textbooks

(Freq of use ind = Frequency of use index)

Appendix E

Sch & Cs ID	Stud Pres	Freq of use ind	Where textbook is used						Access
			Class		Home		Both		
			n =	%	n =	%	n =	%	
1031*									
94B4	23	0.3	4	17.4	14	60.9	5	21.7	Books
95A1	24	0.8	8	33.3	8	33.3	8	33.3	issued for
95A2	28	0.5	12	42.9	3	10.7	13	46.4	the whole
95A3	18	0.9	9	50.0	0	0.0	9	50.0	of Key
95B4	26	0.7	7	26.9	1	3.9	18	69.2	Stage Four
95B5	25	0.7	13	52.0	2	8.0	10	40.0	
95B6	21	0.3	8	38.1	0	0.0	13	61.9	

(Freq of use ind = Frequency of use index)

Appendix E

Table 7.h: Cloze analysis; sections 6.1 and 6.2 (Diet extract).

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1035											
01	25	8	32.0	13	52.0	4	16.0	10.1	22.4	19.6	52.1
02	26	7	26.9	9	34.6	10	38.5	7.8	20.7	17.2	45.7
03	27	3	11.1	4	14.8	20	74.1	4.1	19.1	15.4	38.6
04	23	5	21.7	3	13.0	15	65.2	3.3	15.7	13.4	32.4
05	17	5	29.4	2	11.8	10	58.8	11.2	18.6	17.4	47.3
06	7	0	0.0	0	0.0	7	100	1.3	6.1	4.3	11.7
07	14	0	0.0	0	0.0	14	100	0.8	8.7	10.5	19.9
1029											
1	20	6	30.0	10	50.0	4	20.0	9.5	22.5	18.5	50.5
2	19	9	47.4	8	42.1	2	10.5	10.3	23.5	19.1	52.9
3	16	0	0.0	8	50.0	8	50.0	4.5	18.9	15.4	38.7
4	17	1	5.9	3	17.7	13	76.5	3.9	14.3	14.1	32.3
5	16	0	0.0	0	0.0	16	100	2.1	9.0	8.8	20.0
6	10	0	0.0	1	10.0	9	90.0	1.4	7.9	6.3	15.5

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1036*											
B	12	0	0.0	0	0.0	12	100	0.6	7.3	7.4	15.3
C	14	0	0.0	0	0.0	14	100	2.4	11.6	7.8	21.8
D	16	0	0.0	3	18.8	13	81.3	2.8	13.8	11.6	28.2
F	20	2	10.0	1	5.0	17	85.0	3.9	15.1	13.8	32.8
G	16	2	12.5	2	12.5	12	75.0	4.1	15.3	14.4	33.8
L	14	1	7.1	7	50.0	6	42.9	5.1	21.8	18.2	45.2
P	13	0	0.0	9	69.2	4	30.8	6.0	21.7	16.9	44.6
T	16	2	12.5	5	31.3	9	56.3	6.9	19.4	15.9	42.9
W	16	11	68.8	4	25.0	1	6.3	12.1	25.0	21.2	58.3
Y	18	8	44.5	6	33.3	4	22.2	10.0	23.6	19.3	52.9
Z	16	10	62.5	5	31.3	1	6.3	12.2	24.2	20.5	56.9
1004*											
Blue	14	7	50.0	5	35.7	2	14.3	10.7	23.2	20.4	54.3
Gren	16	9	56.3	2	12.5	5	31.3	10.3	22.8	20.9	53.9
Red	14	7	50.0	6	42.9	1	7.1	11.6	24.0	20.2	55.7
Viol	14	3	21.4	8	57.1	3	21.4	7.7	22.1	17.6	47.3
Yell	16	9	56.3	3	18.8	4	25.0	9.7	22.5	17.3	49.6

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1028											
X1	29	8	27.6	17	58.6	4	13.8	8.0	22.7	18.4	49.1
X2	28	0	0.0	14	50.0	14	50.0	4.3	17.0	14.5	35.8
X3	19	0	0.0	2	10.5	17	89.5	3.0	14.0	12.3	29.3
Y1	30	15	50.0	8	26.7	7	23.3	10.0	23.6	20.0	53.6
Y2	23	1	4.4	4	17.4	18	78.3	3.6	14.8	13.2	31.6
Y3	22	0	0.0	0	0.0	22	100	1.3	7.2	5.6	14.1
1011											
A/C	18	0	0.0	4	22.2	14	77.8	2.7	11.2	9.0	22.9
A/J	21	4	19.1	10	47.6	7	33.3	6.9	20.8	16.2	43.9
A/M	19	2	10.5	8	42.1	9	47.4	5.6	18.9	14.4	38.8
A/R	22	9	40.9	7	31.8	6	27.3	9.1	21.4	18.1	48.5
A/S	15	0	0.0	0	0.0	15	100	1.0	7.5	6.9	15.4
B/H	17	0	0.0	0	0.0	17	100	4.2	15.1	11.9	31.2
B/J	19	2	10.5	11	57.9	6	31.6	7.5	19.3	17.2	44.0
B/M	19	1	5.3	9	47.4	9	47.4	5.7	16.1	13.2	35.0
B/S	15	0	0.0	0	0.0	15	100	0.6	5.6	6.6	12.7
1020*											
3CS3	24	9	37.5	6	25.0	9	37.5	8.3	20.8	18.4	47.5
4CS1	24	2	8.3	8	33.3	14	58.3	4.2	17.1	15.3	36.6
4CS2	17	9	52.9	4	23.5	4	23.5	9.2	24.1	20.0	53.3
5CS1	20	3	15.0	5	25.0	12	60.0	4.8	16.9	14.9	36.6
5CS2	17	0	0.0	6	35.3	11	64.7	6.8	15.9	15.0	37.7

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1010											
10A	21	1	4.8	6	28.6	14	66.7	4.3	16.6	14.2	35.0
10F	23	2	8.7	6	26.1	15	65.2	4.6	17.3	14.9	36.8
10G	24	2	8.3	5	20.8	17	70.8	3.4	14.2	13.8	31.4
10H	24	7	29.2	8	33.3	9	37.5	7.4	21.8	17.9	47.0
10J	21	11	53.4	4	19.1	6	28.6	8.9	23.0	19.6	51.5
1018*											
94M1	25	6	24.0	13	52.0	6	24.0	9.2	21.5	19.6	50.4
95M1	24	8	33.3	7	29.2	9	37.5	7.1	20.3	17.9	45.3
95R1	25	5	20.0	9	36.0	11	44.0	8.1	20.7	17.7	46.6
1007											
93B	13	6	46.2	7	53.9	0	0.0	11.3	26.2	19.9	57.4
93E	12	5	41.7	6	50.0	1	8.3	8.8	25.0	20.4	54.0
94A	14	2	14.3	9	64.3	3	21.4	8.6	24.0	18.5	51.0
94B	22	16	72.7	4	18.2	2	9.1	13.0	24.8	19.1	56.9
94C	21	13	61.9	7	33.3	1	4.8	13.3	26.2	19.7	59.2
94D	21	11	52.4	6	28.6	4	19.1	10.0	22.0	17.6	49.6
94E	16	10	62.5	6	37.5	0	0.0	11.5	26.3	20.5	58.4
94F	16	11	68.8	3	18.8	2	12.5	12.4	26.3	22.1	60.8

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1021*											
34BY	20	13	65.0	6	30.0	1	5.0	12.7	23.8	20.5	57.1
4.1	25	19	76.0	5	20.0	1	4.0	14.1	25.1	19.9	59.1
4.2M	21	11	52.4	7	33.3	3	14.3	11.6	25.2	18.5	55.3
4.2R	17	11	64.7	6	35.3	0	0.0	13.3	26.2	18.7	58.2
4.3K	20	10	50.0	7	35.0	3	15.0	13.3	25.6	19.3	58.2
4.3S	16	4	25.0	2	12.5	10	62.5	6.4	19.1	15.2	40.6
4.3T	14	4	28.6	3	21.4	7	50.0	6.6	20.0	16.8	43.5
1031*											
94B4	23	16	69.6	6	26.1	1	4.4	13.0	26.0	20.2	59.2
95A1	24	9	37.5	13	54.2	2	8.3	9.4	24.3	19.1	52.8
95A2	28	13	46.4	11	39.3	4	14.3	10.2	24.0	19.6	53.8
95A3	18	2	11.1	10	55.6	6	33.3	7.3	21.0	14.6	43.0
95B4	26	11	42.3	13	50.0	2	7.7	10.0	25.3	19.3	54.7
95B5	25	6	24.0	19	76.0	0	0.0	8.9	23.7	19.3	51.9
95B6	21	5	23.8	9	42.9	7	33.3	7.3	21.9	18.2	47.3

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Table 7.i: Cloze analysis; section 12.4 (Kidneys extract).

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1035											
01	25	11	44.0	9	36.0	5	20.0	13.0	15.6	24.1	52.8
02	26	13	50.0	8	30.8	5	19.2	13.3	16.4	23.8	53.5
03	27	1	3.7	11	40.7	15	55.6	8.5	10.9	20.5	39.8
04	23	6	26.1	5	21.7	12	52.2	8.4	12.7	20.6	41.6
05	17	7	41.2	4	23.5	6	35.3	15.3	15.6	20.8	51.7
06	7	0	0.0	2	28.6	5	71.4	6.5	7.3	11.4	25.2
07	14	0	0.0	2	14.3	12	85.7	4.5	7.3	15.7	27.5
1029											
1	20	8	40.0	6	30.0	6	30.0	11.7	14.8	23.6	50.0
2	19	7	36.8	8	42.1	4	21.1	12.5	15.6	22.3	50.4
3	16	1	6.3	4	25.0	11	68.8	10.4	8.7	18.6	37.7
4	17	2	11.8	2	11.8	13	76.5	4.4	7.3	16.9	28.5
5	16	0	0.0	0	0.0	16	100	0.6	3.6	8.9	13.1
6	10	0	0.0	0	0.0	10	100	1.7	3.2	7.6	12.5

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1036*											
B	12	0	0.0	0	0.0	12	100	2.5	4.4	10.6	17.5
C	14	0	0.0	0	0.0	14	100	2.2	5.9	13.9	22.0
D	16	0	0.0	2	12.5	14	87.5	5.1	7.1	16.0	28.2
F	20	0	0.0	3	15.0	17	85.0	5.8	9.0	17.2	32.0
G	16	2	12.5	4	25.0	10	62.5	8.1	11.0	18.5	37.6
L	14	0	0.0	10	71.4	4	28.6	10.5	14.4	21.2	46.1
P	13	1	7.7	5	38.5	7	53.9	10.0	12.9	21.3	44.2
T	16	3	18.8	6	37.5	7	43.8	8.8	12.6	20.8	42.2
W	16	9	56.3	6	37.5	1	6.3	13.9	17.3	24.5	55.6
Y	18	12	66.7	6	33.3	0	0.0	16.6	17.8	25.4	59.8
Z	16	13	81.3	3	18.8	0	0.0	17.9	21.1	25.6	64.6
1004*											
Blue	14	8	57.1	1	7.1	5	35.7	13.2	16.6	25.3	55.2
Gren	16	9	56.3	1	6.3	6	37.5	11.7	14.9	19.7	46.3
Red	14	7	50.0	5	35.7	2	14.3	14.7	16.2	24.1	55.0
Viol	14	5	35.7	3	21.4	6	42.9	12.8	14.3	20.2	47.3
Yell	16	5	31.3	4	25.0	7	43.8	10.2	13.4	20.3	43.9

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1028											
X1	29	9	31.0	9	31.0	11	37.9	11.6	12.8	19.5	43.8
X2	28	1	3.6	5	17.9	22	78.6	5.0	8.3	18.0	31.3
X3	19	0	0.0	3	15.8	16	84.2	6.8	9.0	15.7	31.5
Y1	30	15	50.0	12	40.0	3	10.0	15.1	17.6	23.5	56.3
Y2	23	0	0.0	6	26.1	17	73.9	6.4	8.1	15.6	30.1
Y3	22	0	0.0	5	22.7	17	77.3	6.1	6.2	13.2	25.5
1011											
A/C	18	1	5.6	2	11.1	15	83.3	4.1	6.3	14.5	24.9
A/J	21	3	14.3	13	61.9	5	23.8	12.4	13.4	21.7	47.5
A/M	19	2	10.5	8	42.1	9	47.4	9.3	11.2	18.6	39.1
A/R	22	8	36.4	7	31.8	7	31.8	12.0	13.8	22.2	48.0
A/S	15	0	0.0	0	0.0	15	100	2.4	3.4	8.8	14.6
B/H	17	0	0.0	0	0.0	17	100	6.4	8.0	16.4	30.7
B/J	19	2	10.5	8	42.1	9	47.4	9.5	11.2	20.1	40.7
B/M	19	0	0.0	5	26.3	14	73.7	7.4	9.0	17.6	34.0
B/S	15	0	0.0	0	0.0	15	100	1.6	4.1	11.1	16.7
1020*											
3CS3	24	3	12.5	14	58.3	7	29.2	10.7	14.2	22.6	47.5
4CS1	24	4	16.7	8	33.3	12	50.0	8.9	10.5	19.4	38.8
4CS2	17	4	23.5	7	41.2	6	35.3	13.0	11.9	20.5	45.4
5CS1	20	4	20.0	5	25.0	11	55.0	9.1	11.8	19.7	40.5
5CS2	17	0	0.0	7	41.2	10	58.8	8.2	9.2	18.5	35.9

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1010											
10A	21	2	9.5	7	33.3	12	57.1	7.3	12.3	17.4	36.9
10F	23	0	0.0	10	43.5	13	56.5	6.0	10.4	20.8	37.2
10G	24	4	16.7	7	29.2	13	54.2	7.8	10.6	19.1	37.5
10H	24	7	29.2	7	29.2	10	41.7	10.2	12.9	23.0	46.1
10J	21	9	42.9	8	38.1	4	19.1	13.4	15.9	23.1	52.4
1018*											
94M1	25	2	8.0	14	56.0	9	36.0	12.1	12.1	20.5	44.8
95M1	24	4	16.7	14	58.3	6	25.0	12.2	13.6	20.5	46.3
95R1	25	3	12.0	10	40.0	12	48.0	10.8	11.5	18.8	41.0
1007											
93B	13	8	61.5	4	30.8	1	7.7	15.7	17.7	25.3	58.7
93E	12	4	33.3	8	66.7	0	0.0	15.8	17.0	24.0	56.8
94A	14	1	7.1	10	71.4	3	21.4	10.8	15.1	20.6	46.5
94B	22	15	68.2	6	27.3	1	4.6	15.2	19.7	24.4	59.2
94C	21	10	47.6	10	47.6	1	4.8	16.4	17.0	22.3	55.7
94D	21	11	52.4	6	28.6	4	19.1	13.6	14.8	21.6	50.0
94E	16	11	68.8	5	31.3	0	0.0	16.0	20.0	23.9	60.0
94F	16	12	75.0	3	18.8	1	6.3	15.8	20.0	25.4	61.2

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

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Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1021*											
34BY	20	10	50.0	9	45.0	1	5.0	15.7	19.2	22.4	57.2
4.1	25	20	80.0	5	20.0	0	0.0	18.1	21.2	23.3	62.6
4.2M	21	9	42.9	10	47.6	2	9.5	13.7	17.0	23.6	54.3
4.2R	17	14	82.4	3	17.7	0	0.0	16.0	20.8	25.5	62.3
4.3K	20	9	45.0	6	30.0	5	25.0	12.5	17.5	24.8	54.7
4.3S	16	1	6.3	7	43.8	8	50.0	9.9	12.3	17.8	39.9
4.3T	14	1	7.1	5	35.7	8	57.1	9.4	14.5	20.2	44.2
1031*											
94B4	23	19	82.6	4	17.4	0	0.0	17.0	21.4	25.6	64.1
95A1	24	18	75.0	4	16.7	2	8.3	16.5	18.5	24.7	59.7
95A2	28	13	46.4	11	39.3	4	14.3	14.4	17.9	22.8	55.0
95A3	18	3	16.7	10	55.6	5	27.8	11.0	13.5	19.0	43.5
95B4	26	8	30.8	16	61.5	2	7.7	14.6	16.5	22.9	54.0
95B5	25	21	84.0	4	16.0	0	0.0	16.0	19.2	25.1	60.3
95B6	21	5	23.8	12	57.1	4	19.1	12.4	15.3	22.2	49.9

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Table 7.j: Cloze analysis; section 18.2 (Conservation extract).

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1035											
01	25	0	0.0	9	36.0	16	64.0	5.4	10.1	22.2	37.6
02	26	0	0.0	5	19.2	21	80.8	3.7	9.4	18.5	31.6
03	27	0	0.0	0	0.0	27	100	2.3	5.8	16.9	25.0
04	23	0	0.0	1	4.4	22	95.7	3.5	5.1	16.1	24.7
05+	17	7	41.2	0	0.0	10	58.8	10.0	19.4	21.9	51.3
06	7	0	0.0	0	0.0	7	100	0.5	2.4	8.2	11.1
07	14	0	0.0	0	0.0	14	100	0.3	1.9	13.4	15.5
1029											
1	20	2	10.0	5	25.0	13	65.0	6.0	9.4	21.7	37.1
2	19	1	5.3	8	42.1	10	52.6	4.8	11.6	22.9	39.3
3	16	0	0.0	0	0.0	16	100	2.4	5.4	15.9	23.7
4	17	0	0.0	1	5.9	16	94.1	2.1	3.8	12.4	18.3
5	16	0	0.0	0	0.0	16	100	0.7	1.3	8.7	10.7
6	10	0	0.0	0	0.0	10	100	0.6	1.5	6.9	8.9

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

+ This session was not conducted by the principal researcher but it was reported to him that some of these students had referred to the textbook when making their responses. The 7 students recorded as independent readers achieved scores of over 80% on the task.

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1036*											
B	12	0	0.0	0	0.0	12	100	0.2	0.6	7.6	8.3
C	14	0	0.0	0	0.0	14	100	0.7	1.2	7.7	9.5
D	16	0	0.0	0	0.0	16	100	1.4	3.2	13.0	17.6
F	20	0	0.0	0	0.0	20	100	2.0	2.9	14.2	19.1
G	16	0	0.0	0	0.0	16	100	1.4	4.9	15.2	21.4
L	14	0	0.0	0	0.0	14	100	3.7	7.7	18.1	29.5
P	13	0	0.0	0	0.0	13	100	3.1	10.0	17.2	30.3
T	16	0	0.0	0	0.0	16	100	2.4	7.2	15.7	25.4
W	16	0	0.0	0	0.0	16	100	3.6	10.5	20.5	34.6
Y	18	0	0.0	4	22.2	14	77.8	5.7	11.6	21.7	39.0
Z	16	1	6.3	8	50.0	7	43.8	7.2	13.8	24.0	44.9
1004*											
Blue	14	3	21.4	3	21.4	8	57.1	4.5	11.6	21.7	37.8
Gren	16	0	0.0	10	62.5	6	37.5	6.1	10.9	22.3	39.4
Red	14	0	0.0	5	35.7	9	64.3	5.3	13.2	21.8	40.3
Viol	14	0	0.0	4	28.6	10	71.4	4.9	11.6	22.0	38.5
Yell	16	1	6.3	2	12.5	13	81.3	3.6	8.5	20.5	32.5

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1028											
X1	29	2	6.9	5	17.2	22	75.9	4.7	11.6	19.4	35.6
X2	28	0	0.0	0	0.0	28	100	1.3	5.8	16.3	23.5
X3	19	0	0.0	0	0.0	19	100	1.3	2.2	10.4	13.9
Y1	30	2	6.7	16	53.3	12	40.0	6.7	13.5	25.3	45.4
Y2	23	0	0.0	1	4.4	22	95.7	2.6	5.8	14.3	22.6
Y3	22	0	0.0	0	0.0	22	100	0.9	0.5	7.3	8.8
1011											
A/C	18	0	0.0	0	0.0	18	100	1.2	3.4	11.3	16.0
A/J	21	0	0.0	0	0.0	21	100	3.2	7.8	16.5	27.4
A/M	19	0	0.0	0	0.0	19	100	2.1	8.1	15.8	26.0
A/R	22	0	0.0	2	9.1	20	90.9	4.0	9.4	19.0	32.4
A/S	15	0	0.0	0	0.0	15	100	0.9	1.6	6.7	9.1
B/H	17	0	0.0	0	0.0	17	100	1.2	3.6	12.6	17.4
B/J	19	0	0.0	2	10.5	17	89.5	1.8	5.4	16.7	23.8
B/M	19	0	0.0	0	0.0	19	100	2.4	5.7	15.6	23.7
B/S	15	0	0.0	0	0.0	15	100	0.5	2.0	6.8	9.3
1020*											
3CS3	24	1	4.2	1	4.2	22	91.7	3.5	9.6	19.6	32.6
4CS1	24	0	0.0	1	4.2	23	95.8	2.6	6.6	18.4	27.6
4CS2	17	0	0.0	2	11.8	15	88.2	4.1	7.3	18.4	29.9
5CS1	20	0	0.0	0	0.0	20	100	3.0	4.7	14.9	22.6
5CS2	17	0	0.0	0	0.0	17	100	1.1	5.0	16.6	22.7

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Appendix E

Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1010											
10A	21	0	0.0	1	4.8	20	95.2	3.1	5.8	16.8	25.7
10F	23	0	0.0	3	13.0	20	87.0	2.7	5.6	18.1	26.4
10G	24	0	0.0	3	12.5	21	87.5	1.6	5.6	16.9	24.2
10H	24	0	0.0	7	29.2	17	70.8	3.8	8.5	19.2	31.5
10J	21	2	9.5	5	23.8	14	66.7	6.6	10.5	19.8	37.0
1018*											
94M1	25	0	0.0	1	4.0	24	96.0	2.5	7.7	18.7	29.0
95M1	24	0	0.0	0	0.0	24	100	2.9	7.7	18.5	29.1
95R1	25	0	0.0	0	0.0	25	100	3.3	7.1	17.7	28.2
1007											
93B	13	1	7.7	6	46.2	6	46.2	7.1	14.3	23.7	45.0
93E	12	0	0.0	4	33.3	8	66.7	5.9	12.4	23.8	42.0
94A	14	0	0.0	5	35.7	9	64.3	5.7	9.8	21.4	36.9
94B	22	2	9.1	9	40.9	11	50.0	6.1	12.2	23.2	41.4
94C	21	0	0.0	6	28.6	15	71.4	5.3	10.6	22.8	38.6
94D	21	0	0.0	11	52.4	10	47.6	5.9	13.1	21.2	40.2
94E	16	0	0.0	5	31.3	11	68.8	5.1	10.5	20.4	36.0
94F	16	1	6.3	7	43.8	8	50.0	6.1	13.5	21.5	41.2

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

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Sch & Cs ID	Stud Pres	Level of understanding						Average Cloze Scores			
		Indep		Instr		Frust					
		n =	%	n =	%	n =	%	Lex	Gram	Gen	Tot
1021*											
34BY	20	6	30.0	3	15.0	11	55.0	8.0	13.2	21.7	42.8
4.1	25	4	16.0	15	60.0	6	24.0	8.8	14.1	25.0	47.9
4.2M	21	2	9.5	6	28.6	13	61.9	4.9	10.9	22.6	38.3
4.2R	17	1	5.9	7	41.2	9	52.9	6.2	12.8	22.9	41.8
4.3K	20	2	10.0	6	30.0	12	60.0	4.6	10.9	21.8	37.3
4.3S	16	0	0.0	1	6.3	15	93.8	3.9	7.6	19.6	31.1
4.3T	14	0	0.0	2	14.3	12	85.7	3.6	7.1	17.5	28.2
1031*											
94B4	23	1	4.4	14	60.9	8	34.8	6.4	14.8	24.2	45.5
95A1	24	2	8.3	14	58.3	8	33.3	6.8	15.8	24.7	47.3
95A2	28	0	0.0	12	42.9	16	57.1	5.6	11.8	22.6	39.9
95A3	18	0	0.0	5	27.8	13	72.2	3.9	8.7	20.4	33.0
95B4	26	1	3.9	9	34.6	16	61.5	5.6	12.3	23.0	40.8
95B5	25	1	4.0	10	40.0	14	56.0	5.9	12.7	23.5	42.1
95B6	21	1	4.8	1	4.8	19	90.5	3.6	11.5	21.8	36.9

(Indep = Independent, Instr = Instruction, Frust = Frustration,
Lex = scientific lexis, Gram = scientific grammar,
Gen = school science textbook genre, Tot = average total score)

Table 7.k: Statistical analysis of cloze data.

Extract	Sample Set 1	n1	mean 1	s.d. 1	var 1	Chi.sq. test 1	Sample Set 2	n2	mean 2	s.d. 2	var 2	Chi.sq. test 2	F-test	s	Calc t	df	Tab t 5%	Sig. Diff.
Diet	1004*	74	52.1	15.5	241.2	FAIL	1004#	24	46.3	17.7	313.9	PASS						
Kidneys	1004*	74	49.3	18.3	335.1	FAIL	1004#	24	40.3	19.9	397.5	PASS						
Conserv.	1004*	74	37.6	13.8	191.0	PASS	1004#	24	31.9	14.1	199.0	PASS	PASS	13.89	1.74	96	1.99	No
Diet	1004#	24	46.3	17.7	313.9	PASS	1004+	50	55.0	13.7	187.0	FAIL						
Kidneys	1004#	24	40.3	19.9	397.5	PASS	1004+	50	53.6	15.9	254.3	PASS	PASS	17.32	3.08	72	2.00	YES
Conserv.	1004#	24	31.9	14.1	199.0	PASS	1004+	50	40.3	13.0	167.9	PASS	PASS	13.33	2.53	72	2.00	YES
Diet	1036*	171	39.9	17.1	293.3	FAIL	1036#	18	37.9	18.2	333.0	FAIL						
Kidneys	1036*	171	41.5	18.1	326.3	PASS	1036#	18	37.0	17.3	298.5	PASS	PASS	17.99	1.02	187	1.98	No
Conserv.	1036*	171	25.9	13.6	186.2	PASS	1036#	18	22.0	14.7	216.2	PASS	PASS	13.74	1.14	187	1.98	No
Diet	1036#	18	37.9	18.2	333.0	FAIL	1036+	153	40.1	17.0	290.3	FAIL						
Kidneys	1036#	18	37.0	17.3	298.5	PASS	1036+	153	42.1	18.1	328.8	PASS	PASS	18.05	1.13	169	1.98	No
Conserv.	1036#	18	22.0	14.7	216.2	PASS	1036+	153	26.3	13.5	182.1	PASS	PASS	13.62	1.27	169	1.98	No
Diet	1021*	133	54.1	14.9	221.7	FAIL	1021#	43	53.2	13.6	184.4	PASS						
Kidneys	1021*	133	54.6	14.5	211.3	FAIL	1021#	43	55.1	15.8	250.1	PASS						
Conserv.	1021*	133	39.1	15.3	235.4	PASS	1021#	43	40.9	16.6	274.4	PASS	PASS	15.65	0.63	174	1.98	No

*(Schools with more than 10% bilingual students are marked *, bilingual subsamples are marked #, monolingual subsamples are marked +)*

Extract	Sample Set 1	n1	mean 1	s.d. 1	var 1	Chi.sq. test 1	Sample Set 2	n2	mean 2	s.d. 2	var 2	Chi.sq. test 2	F-test	s	Calc t	df	Tab t 5%	Sig. Diff.
Diet	1021#	43	53.2	13.6	184.4	PASS	1021+	90	54.5	15.5	241.2	FAIL						
Kidneys	1021#	43	55.1	15.8	250.1	PASS	1021+	90	54.3	14.0	195.1	PASS	PASS	14.59	0.31	131	1.98	No
Conserv.	1021#	43	40.9	16.6	274.4	PASS	1021+	90	38.3	14.7	217.4	PASS	PASS	15.35	0.90	131	1.98	No
Diet	1031*	165	52.3	10.5	110.6	FAIL	1031#	30	52.3	13.3	175.9	FAIL						
Kidneys	1031*	165	55.7	12.1	146.7	FAIL	1031#	30	56.3	12.2	149.3	PASS						
Conserv.	1031*	165	41.1	9.9	98.1	PASS	1031#	30	37.2	10.1	102.6	PASS	PASS	9.94	1.99	193	1.98	YES
Diet	1031#	30	52.3	13.3	175.9	FAIL	1031+	135	52.3	9.9	97.3	FAIL						
Kidneys	1031#	30	56.3	12.2	149.3	PASS	1031+	135	55.5	12.1	147.2	FAIL						
Conserv.	1031#	30	37.2	10.1	102.6	PASS	1031+	135	42.0	9.7	93.7	PASS	PASS	9.76	2.44	163	1.98	YES
Diet	1018*	74	47.4	12.2	148.4	PASS	1010	113	40.2	16.9	284.5	FAIL						
Kidneys	1018*	74	44.0	12.1	146.2	FAIL	1010	113	41.9	16.8	281.2	FAIL						
Conserv.	1018*	74	28.7	9.1	82.8	PASS	1010	113	28.7	14.8	219.1	PASS	FAIL					YES
Diet	1020*	102	42.1	16.6	276.7	FAIL	1010	113	40.2	16.9	284.5	FAIL						
Kidneys	1020*	102	41.8	16.0	254.9	PASS	1010	113	41.9	16.8	281.2	FAIL						
Conserv.	1020*	102	27.4	10.6	112.7	PASS	1010	113	28.7	14.8	219.1	PASS	FAIL					YES

*(Schools with more than 10% bilingual students are marked *, bilingual subsamples are marked #, monolingual subsamples are marked +)*

Extract	Sample Set 1	n1	mean 1	s.d. 1	var 1	Chi.sq. test 1	Sample Set 2	n2	mean 2	s.d. 2	var 2	Chi.sq. test 2	F-test	s	Calc t	df	Tab t 5%	Sig. Diff.
Diet	1018#	64	47.8	12.1	146.4	PASS	1020#	46	42.8	16.6	276.4	PASS	FAIL					YES
Kidneys	1018#	64	45.0	10.2	104.1	PASS	1020#	46	39.6	16.8	283.5	PASS	FAIL					YES
Conserv.	1018#	64	28.5	9.2	83.8	PASS	1020#	46	27.1	10.7	114.3	PASS	PASS	9.83	0.74	108	1.99	No
Diet	1018#	64	47.8	12.1	146.4	PASS	1018+	10	45.4	13.2	173.7	PASS	PASS	12.24	0.58	72	2.00	No
Kidneys	1018#	64	45.0	10.2	104.1	PASS	1018+	10	37.1	19.9	397.4	FAIL						
Conserv.	1018#	64	28.5	9.2	83.8	PASS	1018+	10	30.0	9.1	82.9	PASS	PASS	9.15	0.47	72	2.00	No
Diet	1020#	46	42.8	16.6	276.4	PASS	1020+	56	41.6	16.8	281.4	FAIL						
Kidneys	1020#	46	39.6	16.8	283.5	PASS	1020+	56	43.6	15.1	229.1	PASS	PASS	15.92	1.23	100	1.99	No
Conserv.	1020#	46	27.1	10.7	114.3	PASS	1020+	56	27.5	10.6	113.4	PASS	PASS	10.67	0.19	100	1.99	No
Diet	1018*	74	47.4	12.2	148.4	PASS	1020*	102	42.1	16.6	276.7	FAIL						
Kidneys	1018*	74	44.0	12.1	146.2	FAIL	1020*	102	41.8	16.0	254.9	PASS						
Conserv.	1018*	74	28.7	9.1	82.8	PASS	1020*	102	27.4	10.6	112.7	PASS	PASS	10.01	0.88	174	1.98	No
Diet	1029a	20	50.4	10.8	116.5	PASS	1029b	19	52.9	13.4	179.7	PASS	PASS	12.13	0.63	37	2.02	No
Kidneys	1029a	20	50.0	15.5	239.7	PASS	1029b	19	50.4	17.2	294.9	PASS	PASS	16.33	0.08	37	2.02	No
Conserv.	1029a	20	37.1	13.3	177.0	PASS	1029b	19	39.3	12.8	162.9	PASS	PASS	13.05	0.51	37	2.02	No

*(Schools with more than 10% bilingual students are marked *, bilingual subsamples are marked #, monolingual subsamples are marked +*
1029a = School 1029 Class 10 Set 1, 1029b = School 1029 Class 10 Set 2)

In the above analysis, an 'unpaired samples' t-test was used to check for a significant difference (5% significence level) between the means of pairs of populations by comparing the means of their sample sets. The method used was the one described by Rees [1985 p.109]. Each sample set consisted of a set of cloze task test results for a specified school and extract type and in the above table:-

The validity of the t-test relies on the following two assumptions:-

1) The distribution of individual samples within each sample set must approximate to the normal distribution. In order to verify this assumption, a Chi-squared goodness of fit test, as described by Rees [1985 pp. 173-176] was applied to each sample set, to check whether the distribution approximated to the normal distribution (5% significence level).

2) For each comparison, the standard deviations of the two populations compared must be the same. An F-test, as described by Mulholland and Jones [1968 p.203], was use to check whether there was a significant difference (5% significence level) between the standard deviations of each of the pairs of compared sample sets.

Appendix E

Table 7.1: A summary of the data collected through student interviews

Group A Boys from Set 4

Group members and languages spoken in addition to English

Mahim	Panjabi & Urdu
William	Cantonese
Talat	Panjabi & Urdu
Urksi	Gujarati

Final order of priority

The use of clear language
A clear structure to the whole book
A glossary
Good layout
Clear diagrams
Scientific diagrams
Science in everyday contexts
The use of scientific language
Attractive design

Do you like using the Nuffield Co-ordinated Sciences Biology book?

No

Why do you feel like that about it?

It's too hard to understand. There needs to be a summary at the end of each chapter. The writing is too small. Especially the index at the back. They're trying to fit a lot of stuff into one page. There's no glossary. There should be more description with each diagram. There should be more writing about the diagrams. It's too old fashioned. It should be more like *Biology for Life* with tests at the end of each section or chapter so that you know what you're doing. You can test yourself. Then you can find your weaknesses from the tests and go over it again. It's the pictures and the looks and the fonts which make it old fashioned. It's what's in the pictures which make it look old fashioned. The pages are dull. Many of the questions in a section are similar. What's the point of doing similar questions? I don't like the references to other sections and the other textbooks which we don't have. It's better when there are questions on a previous paragraph.

Which sections helped you a lot?

None

Appendix E

Which sections were difficult?

The whole book was pretty hard. The farming and agriculture (**B17**) was difficult, it didn't have enough information to answer the questions and it referred you to the Chemistry book.

What would make the book better?

A glossary. Questions at the end of sections. A summary at the end of each section. It's really hard to revise from because it just gives you information and questions. Make it easier to revise from by having questions at the end of each chapter and at the end of the book with answers. These questions could get harder as you go down the page. They could gradually get more complicated. I find things like Figure 1.7 difficult (*Figure 1.7 is a matrix of nine photographs of different animals*). I don't even look at the pictures unless they're related to the work. I don't need pictures like Figures 23.4 and 23.5. I don't need to know what Charles Darwin looked like. There should be more pictures like the leaf sections. There should be diagrams like those you're going to face in the exams. Diagrams like Figures 22.13 and 22.14 are very difficult to understand (*These are diagrams showing chromosomes and genetic crosses. They are complex scientific diagrams.*). That's the sort of thing which I find difficult to understand. Things like that could be made easier to understand. There could be more comparisons like between plants and animals. There should be colour on every page. With the black and white pictures you can't see the pictures properly. One page is in colour, the next is in black and white. The Chemistry and Physics Nuffield books are better than the Biology. They are a bit easier to understand. They are better written and everything is in colour. They should give the information referred to from the Chemistry and Physics books in this book. The book could be better set out with all the questions in one section of a chapter rather than spread out in the text. The diagrams could have been made bigger and some of the cartoons and photographs could have been left out all together. Large irrelevant photographs could have been replaced with useful diagrams. The type size should be bigger, some of the text size is so small you can't read it. *Biology for Life* is better because it has larger diagrams which are generally relevant for the work.

Appendix E

Group B Girls from Set 3

Group members and languages spoken in addition to English

Catherine Cantonese
Catherine
Diana
Tania

Final order of priority

A clear structure to the whole book
The use of clear language
Scientific diagrams
Clear diagrams
Good layout
The use of scientific language
Science in everyday contexts
A glossary
Attractive design

Do you like using the Nuffield Co-ordinated Sciences Biology book?

It's OK. I find it hard. I like other books more. It's difficult.

Why do you feel like that about it?

The questions are difficult, there are other books like *Biology for Life* with easier questions. *Biology for Life* is better written. The questions are easier to understand in *Biology for Life*. The language in *Biology for Life* is simpler. The questions in *Biology for Life* are like mini assignments at the end of a chapter. It means that you can concentrate on a topic at a time. Whereas in the Nuffield book sometimes you've got to read a whole section to find the answer to a question that's in the text. It's difficult to find the answers to the questions in the Nuffield Biology book. Sometimes it's difficult to work out what the question means. Sometimes I don't understand what it's saying. The questions interrupt the text. There are questions where the answer is not in the book.

Which sections helped you a lot?

None. The diagrams are a lot simpler in *Biology for Life*.

Which sections were difficult?

Osmosis (**B**10), Genetics (**B**22)

Appendix E

What would make the book better?

I don't think the chapter headings and organisation are very good. Questions should be the end of each topic but not with the answers because people would cheat. Maybe including some of the answers like the Physics book. I don't think the way the chapters are set out is very good. They could be better organised. There could be a section at the back which helped you with the questions without actually giving you the answer. It would help if the revision questions were based on exam questions.